On Federal Transfers and Incentives

Dissertation zur Erlangung des akademischen Grades
eines Doktors der Wirtschaftswissenschaften durch die
Technische Universität Chemnitz

Mai 2009

Martin Altemeyer-Bartscher
Jablonskistraße 11
10405 Berlin

On Federal Transfers and Incentives

Martin Altemeyer-Bartscher

Mai 2009

Contents

Erklärung

Ich erkläre, die hier vorliegende Dissertation selbständig verfasst zu haben, und andere als die angegebenen Hilfsmittel nicht benutzt zu haben. Weitere Personen, insbesondere Promotionsberater, waren an der geistigen Herstellung dieser Arbeit nicht beteiligt. Weder früher noch zum jetzigen Zeitpunkt habe ich ein Promotionsverfahren an einer anderen Stelle beantragt. Die Abhandlung wurde bisher keinem wissenschaftlichen Gremium vorgelegt.

Chemnitz, 18. Mai 2009

Martin Altemeyer-Bartscher

Nichttechnische Zusammenfassung

Ein wichtiger Bestandteil in vielen föderalen Staaten ist ein umfangreiches Transfersystem, welches insbesondere durch seine redistributive und effizienz-sichernde Rolle gekennzeichnet ist. Insbesondere werden interregionale externe Effekte durch ein geeignetes Schema von Kofinanzierungen in der Tradition von Pigou korrigiert und fiskalische Disparitäten zwischen den einzelnen Regionen durch ein Finanzausgleichssystem nivelliert. In einer idealen Föderation, in der es einerseits keine Beschränkungen hinsichtlich der Politikinstrumente gibt, und anderseits alle relevanten Informationen frei verfügbar sind, gilt ein Transfersystem in zentralstaatlicher Verantwortung als Gegenstück einer regionalstaatlichen Bereitstellung von öffentlicher Gütern - ein Ausgleich von Disparitäten und eine vollständige Korrektur der Fehlanreize ist stets möglich.

In der Literatur wird argumentiert, dass lokale Regierungen wegen ihrer räumlichen Nähe zu den Problemen vor Ort regional-spezifische Umstände besonders gut einschätzen können. Hinsichtlich des Dezentralisierungstheorems wird daher eine dezentrale Bereitstellung von öffentlichen Gütern häufig durch den Informationsvorsprung der lokalen Ebene gerechtfertigt. Läßt sich allerdings ein Hauptgrund für Dezentralisierung aus ökonomischer Sicht auf das Spezialwissen der regionalstaatlichen Entscheidungsträger zurückführen, so ist es plausible, dass dem Oberverband gewisse lokale Informationen zur Bemessung der Transferzahlungen verborgen bleiben.

In einem kürzlich erschienenen Überblicksartikel über den Stand des fiskalischen Föderalismus nimmt Oates (2005)[1] eine fundamentale Unterscheidung zwischen der sogenannten ersten Generation der Theorie des Föderalismus und der zweiten Generation vor. Kennzeichnend für die zweite Theoriegeneration ist nach Oates die Einbeziehung asymmetrischer Informationen und polit-ökonomischer Aspekte. Die Modelle, die wir zur Analyse der Beziehungen zwischen Gebietskörperschaften in vertikal und horizontal strukturierten Föderationen, insbesondere der Transferbeziehungen zwischen Gebietskörperschaften, konzipieren, beinhalten zumeist eine asymmetrische Informationsstruktur und gehören damit der zweiten Theoriegeneration des fiskalischen Föderalismus an.

Anknüpfend an die zweite Generation der Literatur ist das Ziel dieser Arbeit eine umfassende Untersuchung des optimalen Designs von anreizkompatiblen Transfermechanismen in föderalen Systemen, vor allem vor dem Hintergrund der möglichen Informationsasymmetrien zwischen den einzelnen Regierungsebenen. Diese Problematik wird darüber hinaus im Rahmen eines Modells mit vielschichtigen Interdependenzen auf der Ebene nachgeordneter Gebietskörperschaften untersucht. Zudem wollen wir die Effekte der vertikalen strategischen Interaktionen in einer Föderation in bezug auf die Anreizkompatibilität von beabsichtigten Transferzahlungen mit redistributivem Charakter betrachten.

Was den informationsökonomischen Teil dieser Arbeit betrifft, so können wir uns auf die umfassende Literatur zur Vertragstheorie, der Theorie der verborgenen Handlung und der Prinzipal-Agenten Theorie stützen. Es ist wohl nicht übertrieben, wenn man, ähnlich wie Oates (2005), davon spricht, dass ein Großteil der Resultate, welche die erste Theoriegeneration hervorgebracht hat, unter informationstheoretischen Aspekten modifiziert oder gar neu geschrieben

[1] Oates, W. (2005) Toward A Second-Generation Theory of Fiscal Federalism, International Tax and Public Finance, vol. 12(4), pp 349-373.

werden muss.

Ein allgemeiner Zielkonflikt zwischen den Regionalstaaten, die jeweils dem Wohl der ansässigen Bevölkerung verpflichtet sind, ist neben einer dezentralisierten Datenerfassung die zweite wichtige Ursache für Fehlanreize in einem föderalen Gefüge. Einerseits stehen lokale Regierungen bei der Besteuerung im Wettbewerb um mobile Faktoren, wie zum Beispiel Kapital und Firmen. Andererseits kommt es zu einem Wettbewerb um Zuweisungen aus gemeinsamen föderalen Finanztöpfen. Damit unterscheidet sich diese Arbeit im Wesendlichen von den üblichen Prinzipal-Agenten Modellen aus der Regulierungstheorie oder des sogenannten "Administrativen Föderalismus", wo derartige Interaktionen nicht betrachtet werden.

Durch die informationstheoretische Sichtweise, die in dieser Arbeit vornehmlich eingenommenen wird, sollen neue Interpretationen und Erklärungen für altbekannte Fragen und Probleme des Finanzausgleichs erörtert werden. Dies ist somit gleichzeitig als eine Antwort auf die an der ersten Generation der Theorie des Föderalismus geäußerte Kritik zu sehen, wonach der darin latent vorhandene, in der Regel nicht zu befriedigende Informationsbedarf daran zweifeln lässt, ob aus dieser Theorie überhaupt implementierbare Mechanismen im Finanzausgleich hervorgehen können. Gerade die Implementierbarkeit von Mechanismen ist aber eine entscheidende Voraussetzung für deren praktische Anwendung.

Zusammenfassend lässt sich somit folgende Kernfrage formulieren:
In welcher Weise können sich lokale Regierungen einen Handlungsspielraum sichern, um zusätzliche Zuweisungen aus föderalen Töpfen zu erhalten, falls diese in einem interregionalen Wettbewerb stehen? Wie sollten föderale Transfersysteme gestaltet sein, damit lokale Regierungen keinen Anreiz haben unberechtigte Ansprüche auf lokale Zuweisungen zu erheben ohne dabei die redistributive Rolle

zu vernachlässigen?

Unter der Zielsetzung Anreizprobleme in föderalen Staaten aufzudecken und den optimalen föderalen Transfermechanismus zu analysieren, teilt sich die Arbeit im wesentlichen in fünf Kapitel auf. In Kapitel 3 bis 6 werden wir innerhalb eines modell-theoretischen Rahmens Föderationen analysieren, die vor allem durch eine asymmetrische Informationsstruktur geprägt sind. Im siebten Kapitel wenden wir uns dann einer Föderation mit einer vollkommenen Informationsstruktur auf horizontaler Ebene zuwenden. Die einzelnen Kapitel und ihr Beitrag sollen im folgenden kurz zusammengefasst werden:

Im *dritten Kapitel* betrachten wir eine Föderation, in der heterogene Regionen im Wettbewerb um eine gemeinsame Steuerbasis stehen. Im Rahmen des Modells offeriert der Oberverband ein föderales Transfersystem, um Disparitäten zwischen den Regionen auszugleichen und fiskalische Externalitäten zu korrigieren. Aufgrund von Informationsassymmetrien können die lokalen Regierungen einen gewissen Spielraum gewinnen, um zusätzliche Transfers aus den föderalen Finanztöpfen zu beziehen. Insbesondere versuchen sie im Rahmen des Steuerwettbewerbs geringe Steueraufkommen durch höhere föderale Zuweisungen zu substituieren. Wir entwickeln ein anreizverträgliches Bayesiansiches Transferschema, welches das Anreizproblem auf lokaler Ebene löst. Als neuen Beitrag zur Literatur zeigen wir, dass eine Separation der einzelnen Informationstypen im Mechanismus zu geringeren Informationskosten führt, falls lokale Regierungen nicht nur um Transfers, sondern auch um mobile Steuerbasis konkurrieren. In diesem Sinne erweißt sich Steuerwettbewerb als vorteilhaft, da im Finanzausgleich höhere Ausgleichsraten erzielt werden.

Falls der Oberverband einer Föderation sich nicht glaubhaft zu einer festen Ausschüttungsregel von Zuweisungen verpflichten kann, kommt es häufig zu

einem Ex-Post Dilemma. Das weitreichende Anreizproblem, welches sich aus der zeitlichen Inkonsistenz des Transferschemas ergibt, soll im *vierten Kapitel* analysiert werden: Lokale Regierungen, die sich stets auf föderale Hilfe verlassen können, sind zum Beispiel geneigt weniger Vorkehrungen zu treffen, um negative Schocks abzumildern. Allerdings läßt sich das Unvermögen des Oberverbandes die Ausschüttungsregeln ex ante zu definieren häufig auf eine asymmetrische Informationsstruktur zuruckführen. Unser Anliegen ist daher eine genaue Untersuchung der Auswirkungen des Ex-Post Problems aus informationsökonomischer Sicht. In einem Modell mit asymmetrischer Information und einem mehrstufigen Spiel zeigen wir, dass lokale Regierungen bei einer hohen Abhängigkeit von föderalen Transfers nur einen eingeschränkten Spielraum bei der Gestaltung ihrer lokalen Finanzpolitik haben. Die Perspektive auf einen vergrößerten Handlungsspielraum ermöglicht es lokalen Regierungen höhere Informationsrenten zu beziehen. Wir zeigen, dass diese Perspektive beträchtliche Anreize für eine langfristige Investitionspolitik stiften kann.

In Föderationen mit einer starken interregionalen Verflechtung ist es plausibel, dass die lokalen Informationstypen mit einander korrelieren - so argumentieren wir im *fünften Kapitel*. Es ist zum Beispiel denkbar, dass benachbarte Regionen in vergleichbarer Weise mit exogenen technologischen Schocks konfrontiert werden. In solchen Fällen kann der Oberverband durch Einführung eines geeigneten Transferschemas einen so genannten Maßstabswettbewerb auf lokaler Ebene fördern. Lokale Informationstypen sind für den Oberverband unbeobachtbar. Jedoch wird die Schärfe des Informationsproblems verringert, wenn lokale Politikgrößen miteinander vergleichbar sind. Die Politik einer Nachbarregion kann bei der Bewertung der Situation in einer bestimmten Region dienlich sein. In einem zweiten Schritt zeigen wir das sich der Maßstabswettbewerb auch

auf langfriste Informationsanreize positiv auswirken kann. Damit hat dieser Wettbewerb auch Implikationen für das im vierten Kapitel analysierte Ex-Post Problem.

Im *sechsten Kapitel* betrachten wir einen Finanzausgleich, dessen Bemessungsgrundlage die Differenz der Steuerbasis in den einzelnen Regionen zu einem Durchschnittswert ist, in Anlehnung an den kommunalen Finanzausgleich in Deutschland beziehungsweise den *RTS grants* in Kanada. In der Literatur ist bekannt, dass es bei einem Ausgleich der Steuerbasis zu einem Rückkopplungseffekt kommt, der zu mindest teilweise die externen Effekte des Steuerwettbewerbs korrigiert: Lokale Regierungen, die durch Steuerdumping zusätzliche Steuerbasis anwerben, haben gleichzeitig einen geringen Anspruch auf Zuweisungen im Rahmen des Steuerbasisausgleichs. Falls die lokalen Regierungen jedoch einen gewissen Handlungsspielraum bei der Steuervollstreckung haben, kann ein solches Schema Ursprung für weitere Ineffizienzen sein. Lokale Regierungen können versuchen durch Anpassung der Steuervollstreckungspolitik einen Steuerwettbewerb über andere Politikvariablen zu führen. Wir entwickeln daher ein Baysianisches Transferschema, das diese Fehlanreize lösen soll. Wir zeigen, dass ein Teil der Informationsrenten durch ein Schema extrahiert werden kann, welches die lokalen Politikmaßnahmen in zweifacher Weise verzerrt und sich somit von den Ergebnissen der herkömmlichen Prinzipal-Agenten Modellen unterscheidet. Vornehmlich erweißt sich der Steuerwettbewerb in Analogie zu den Ergebnissen des dritten Kapitels als vorteilhaft bei der Lösung des Informationsproblems. Diese Tatsache sollte bei der Bemessung des Ausgleichstransfers beachtet werden um optimale Rückkopplungseffekte aus informationsökonomischer Sicht zu erreichen.

Im *siebten Kapitel* verändern wir den einheitlichen modell-theoretischen Rah-

men ein wenig und betrachten ein föderales System, in dem zu mindest auf lokaler Ebene die regional-spezifischen Informationen allgemein bekannt sind. Hier soll ein Transferschema entwickelt werden, welches das Problem einer Unterbereitstellung von globalen öffentlichen Gütern auf supranationaler Ebene löst. Wenn globale öffentliche Güter auf regionaler Ebene bereitgestellt werden, fehlt oft eine globale Instanz, die ein internationales Regulierungsschema glaubhaft vollstrecken kann. In unserem Modell betrachten wir ein Szenario, in dem die einzelnen Regionen über internationale Umweltpolitik verhandeln begleitet von einem System von Seitenzahlungen zwischen den jeweiligen Regionen. Dabei werden die Seitenzahlen durch regionale Umweltsteuern finanziert, die gleichzeitig die externen Effekte von Umweltschäden korrigieren sollen. Seitenzahlungen und nationale Steuern sind somit in wechselseitiger Beziehung bestimmt. Bezogen auf die Verhandlungsebene basiert das anreizverträgliche Transferschema, welches hier Anwendung findet um eine pareto-effiziente internationale Umweltpolitik zu erreichen, auf den Grundsätzen des Coase Programms. Wir stellen in diesem Kapitel ein sehr allgemeines Transferschema vor, das viele Anreizprobleme in einem föderalen Kontext mit interregionalen Externalitäten lösen kann.

Chapter 1

Introduction

1.1 Transfers and Competition in Federal States

As a common feature in federal states, the central government offers a system of grants to lower level governments. Basically, federal transfer policy involves both a redistributive role and an externality-correcting role: local governments do not take into account trans-boundary benefits and costs of local tax and expenditure policy, so that a corrective federal transfer in the Pigouvian tradition is necessary. Further, federal governments in most instances engage in equalizing fiscal disparities. In general the central government intends to achieve fiscal equity, guarantee a minimum standard of public services, assure a minimum welfare level or share interregional risks among local governments.[1] In an ideal federation with complete information and no restrictions on policy instruments, equalizing grants are often seen as a counterpart to decentralization as fiscal disparities are fully equalized and external effects are fully corrected, see e.g. Boadway (2004), Bucovetsky and Smart (2006) and Köthenbürger (2002).

In general, the first generation of the literature on fiscal federalism has overlooked the explicit considerations for why local public services are provided decentrally and centers solely on its role in insuring local governments against region-specific shocks and correcting trans-boundary external effects. However

[1] see Boadway (2008) for a survey.

one must keep in mind that the provision of local public goods has been assigned to local governments because of their informational advantage. If one of the main economic rationale for decentralization lies in local governments' specific knowledge, about regional circumstances it seems to be plausible that the central government faces difficulties in completely checking local performance and offering appropriate transfer schemes; see Arrow (1963). Likewise, the shortcoming of the first generation literature is that the federal government is assumed to be omniscient when it offers a grant rule to local jurisdictions despite the aforementioned informational asymmetries.

Recently some papers have tried to close this gap in the theoretical literature examining the problem of asymmetric information in federal states and the design of interregional grants in a formal way; see Boadway et al. (1998), Bordignon et al. (1996), Raff and Wilson (1995), Lockwood (1999). In particular this strand of literature takes into account that in the real world the central government typically cannot peg transfers directly on the region-specific situation as well as on local governments' policy measures as it has incomplete information about local circumstances so that it must offer transfers on observable variables.

In addition to decentralized information gathering, the second important ingredient of the incentive problems presented in this study is a conflict of objectives between local governments. Local governments in federal states use to compete with one another for mobile resources and for grants from the common pool of federal funds. The essential paradigm for the analysis of competitive behavior is one where economic decision makers act at least partly in their own interests. When engaging in competition local governments may strategically choose different variables, such as tax rates, public expenditures, tariffs, tax enforcement effort.

The problem of horizontal tax competition captures the major part of the literature on inter-regional competition. Jurisdictions raise taxes on mobile capital to finance local public good provision. Thereby local governments are concerned about the outflow of capital if it is taxed too much. Consequently, local governments choose inefficiently low tax rates and, hence, under-provide local public goods. If capital is assumed to be mobile among local jurisdictions but fixed within the borders of a federation out flown capital from a particular jurisdiction is employed in neighboring regions and therefore entails positive fiscal externalities which need to be internalized, see Wilson (1986), Zodrow-Mieszkowski (1996), Wildasin (1989).

Intrinsically, inter-jurisdictional mobility should be seen as a constraint to the source of taxation, which can be given to the local government. Whether tax competition is beneficial or harmful for the overall welfare crucially depends on the framework of the model. In this study we keep the common assumption that local decision makers are locally benevolent so that an additional constraint on policy measures is harmful. Nevertheless, some papers have taken a different perspective assuming that regional states are governed by Leviathans who intend to maximize the size of public service facilities. If the size of the government is excessive tax competition may be a corrective device taming Leviathans; see Rauscher (1996, 1998) and Edward and Keen (1996). Below, we will address the issues of the political economy approach in more detail.

Intrinsically, the competition for mobile transfers in a federal state is reminiscent of the *Rotten Kid Theorem*, which has been formulated by G. S. Becker in his work *A Treatise on the Family* (1981). Basically, Becker describes a set-up with several selfish family members as well as a benevolent family head acting in the interest of all other family members. The theorem claims that "... redis-

tribution of income among family members would not affect the consumption of any member, as long as a head continues to contribute to all."(p.1076) In particular "...each beneficiary, no matter how selfish maximizes the family income for his benefactor and thereby internalizes all effects of his action on the other beneficiaries." (p.183)

In the framework presented by Becker family members anticipate that a benevolent head is concerned about disparities among family members and hence steps in to pay positive transfers. Hence, given a setting with only one normal good as well as a fix budget constraint of the family head, any economic activity enacted by a kid which goes along with adverse effects for her siblings reduces her own pay-off after transfer payments so that kids internalize external effects on the other family members. The idea of the *Rotten Kid Theorem*, which plays an important role in the theory of the family can be applied to the theory of fiscal federalism. Roughly speaking, the structure in a federal state is similar to that of a family. Here, the federal government is concerned about overall efficiency, while local governments act in the interest of households living in the region. In this case it would be sufficient to pay lump-sum transfers to local governments in order to meet both efficiency and equity goals. Local governments would correctly anticipate that the only way to increase local welfare after central government's transfers payments are enacted is to increase the performance of the whole federation. Thus, inter-regional external effects are internalized which proves the *Rotten Kid Theorem*.

Before drawing an all-too positive picture from intergovernmental fiscal relations in a federal state when a federal transfer scheme is in place one should pay attention to those cases in which the *Rotten Kid Theorem* may go wrong. Bergstrom (1989) points out, that rotten kids may become lazy if there is a sec-

ond commodity in the model. In this case local governments (or kids) have some degree of freedom to increase local welfare at the expense of the federation as a whole. The literature in the theory of fiscal federalism has examined in detail some incentive problems which may occur if local governments have a degree of freedom choosing a policy that shifts some cost to the fiscal commons.

Local governments try to shift the burden of financing local public goods on the federation as a whole, substituting higher grants-in-aid for tax revenue, see Huber et al. (2002) and Prud' homme (1995). In this case local governments may have some freedom of action in order to reduce the tax effort and disburden the private sector. Moreover in many federal settings local governments have some latitude of discretion to recast expenditures originally dedicated to long-term investments for short-term public consumption. In particular in the presence of federal insurance they under-invest in the modernization of public infrastructure and public services as the consequential costs of policy shortfalls are not fully reflected by local governments, see Rodden (2001), Goodspeed and Haughwout (2006), Köthenbürger (2007).

The theory has well understood that central government can achieve an efficient allocation in an environment with full information and no restrictions on the set of policy instrument by offering a corrective transfer scheme. In the context of this study an externality-correcting grant rule may be interpreted as follows: the central government opens up a new option for local governments to engage in common pool fishing by offering co-funding grants. Local governments may be eligible to additional co-funding grants if they change their policy measure. At the margin the benefit receiving an additional euro from the common pool by changing local policy should offset the external effects. Sometimes the entitlement of the transfer scheme comes along well so that the *Rotten Kid*

Theorem is recovered: Bucovetsky and Smart (2007) as well as Köthenbürger (2002) have shown that the advantage of tax competition can be neutralized if the entitlement to benefit from tax revenue equalizing grants changes at the margin by the same extent - this is the so called tax back effect. Otherwise, the central government explicitly offers co-funding programs contingent on local policy measures as well as region-specific circumstances implementing the optimal local policy.

In general the federal government cannot offer a transfer scheme which implements an efficient local policy in the presence of asymmetric information. On the one hand the central government does not know the magnitude of the externality to define a matching rate. On the other hand it cannot observe some of the policy measures so that local governments have an incentive to choose an untruthful policy which may be a source of new inefficiencies. Then, local governments have some scope to draw additional grants from the common pool and engage in competition for federal transfers.

A challenge of this study is to visualize the competition between local governments and detect the source of possible disruptions. Then we are able to design an optimal transfer scheme, which recovers incentive-compatibility. For a more profound analysis of the underlying incentive problem we lay emphasis on the fact that the competition with specific variables may be based on different processes and mechanisms. For example tax competition can be based on the mobility of individuals, goods, factors or firms. Instead it can be founded on local governments' entitlement to benefit from grants if a change in their tax policy makes local governments eligible for additional transfer.[2] Further, local governments can reduce their tax burden by using grants instead of tax revenue while

[2]Likewise, Salmon (2008) has recently describe the interdependence between yardstick competition and mobility based tax competition.

at the same time they can gain a competitive advantage in the tax competition game and attract more capital. In order to understand the incentive problem, which may arise in federal states with a federal transfer system and mobility of resources, we must first of all analyze in detail the underlying mechanism.

Accordingly, the study is inspired by the literature on the mechanism design approach. At the center of the analysis we formulate an incentive-compatibility condition in order to find transfer schemes which tackle common pool fishing. Intrinsically, we show that the separation of efficiency and redistribution in the full information setting presented in the first generation of the literature does not hold in a setting with asymmetric information. The central government must offer positive information rents in order to implement a truthful local policy. Here, redistributive aims and an allocative object cannot be disentangled but must be seen together. This calls for an integrated solution as was already claimed in the early literature on inter-personal redistribution, see Mirless (1971) and Stiglitz (1982).

The novel contribution of this study is that we claim that local governments are linked through their treasuries and resource allocation: anticipating these interdependencies the central government may attempt to benefit from the competition between regional governments to relax informational constraints and reduce the information rents which must be paid to induce a truthful local policy.

Sometimes the federal government can exploit the fact that regionally benevolent jurisdictions do not internalize the informational externalities on neighboring jurisdictions when they pursue local policy measures. In particular local governments do not take into account that their policy measures serve as a signal for correlated types of neighboring jurisdictions. Therefore, the central government

can learn more about local circumstances without offering information rents.

Further we consider a set of transfers which implement an optimal local policy in an environment with complete information. At the supra-national level, there do not exist strong institutions for coordinating the policy measures enacted on the local level. In this case local governments can offer reciprocal side payments to their neighbors in order to enable cooperation among local governments.

1.2 Purpose of the Study

Reality has shown that poorly designed transfer systems can have harmful consequences for both federal efficiency and equity.[3] These shortfalls have received vast attention in the second generation of the literature on fiscal federalism but it is far from being comprehensive at this moment. The purpose of this study is to contribute to the second generation of the literature on fiscal federalism which analyzes the federal transfer mechanism in the presence of incomplete information and commitment devices.

Recapitulating, the basic questions of this study can be formulated as follows: *To which extent can local governments in a federal state, which compete with each other, gain some latitude of discretion to draw some additional grants from the common pool of federal funds. How must a federal transfer scheme be designed that tackles common pool fishing and at the same time fulfills the allocative and distributive objectives of the federal government?*

1.3 Limits of the Study

Principally, the work is relatively analytical rather than descriptive. Little discussion about detail applied policy problems in federal states is given. There is no detailed treatment of country-specific issues and institutional structures.

[3] Rodden (2001), Baretti et al. (2002) point out shortfalls of federal transfers in Germany.

However the framework of the basic model, which is presented in this study, is in agreement with the basic situation in many federal states. Furthermore this study excludes empirical issues. Nevertheless in the following chapters we are going to cite several empirical studies, which provide evidence for the basic assumption made in the models and for the investigated incentive problems.

1.4 Outline of the Dissertation

This thesis presents five different settings in federal states with inter-regional transfer systems. The first four chapters describe a setting with informational asymmetries with respect to fiscal needs as well as to fiscal capacity. The last chapter considers a transfer scheme, which is going to internalize interregional spillover effects in a full information set-up. The different chapter and their respective contributions are summarized hereafter.

1.4.1 Beneficial Tax Competition

In the third chapter of this study we consider a federal state with heterogenous jurisdictions engaging in strategic tax competition. In the frame of the model the federal government offers a federal transfer scheme in order to correct fiscal externalities and equalize fiscal disparities. We show that local governments have some latitude of discretion when drawing additional grants from the common pool of federal funds if local governments are better informed about relevant local circumstances. Especially, in a federal state with inter-regional tax competition local governments may tend to substitute higher grants-in-aid for tax revenue. We design an optimal Bayesian redistribution mechanism in order to tackle incentive problems at the local level. As a novel contribution to the literature we show that the separation of informational types in the mechanism entails lower informational cost if local governments do not only compete for

federal transfers but also for tax bases. In this spirit tax competition is beneficial as the federal government can offer grants with a higher contribution rate so that disparities among local governments are equalized by a higher extent.

1.4.2 The Ex-Post Dilemma in Fiscal Federalism

We show that local governments' incentives to provide public goods may be distorted if the central government cannot offer fix grant rules ex ante. If federal grants-in-aid get determined ex post, i.e. after local policy measures have been chosen, local governments may influence federal transfer payments by strategically choosing local policy measures. For example local governments which rely on federal aid may tend to under-invest in precautionary long term-policy measures running the risk of high consequential costs in the future. In the fourth chapter we analyze this wide-spread incentive problem based on the time-inconsistency of transfer schemes. Indeed, the central government' s incapacity to offer a well-defined transfer scheme ex ante is often rooted in an asymmetric information structure predominant in the federal state. Our main concern is therefore to analyze the consequences of the ex-post redistribution problem from an information-based perspective. Considering a two-stage game with asymmetric information we show that local governments which highly depend on federal grants-in-aid may have a limited scope to freely enact local fiscal policy. The local government's perspective to enlarge the latitude of discretion for local fiscal policy allowing them to draw higher informational rents from the common pool may provide considerable incentives for local precautionary investments. Although fully insured by a federal redistribution mechanism, local governments are at least partly residual claimant of their own policy. This provides incentives for long-term projects reducing the likelihood of negative future shocks.

1.4.3 Transfers and Informational Externalities

In federations with spatial interrelation, it is plausible that technology types correlate between jurisdictions. In the fifth chapter we show that local policy performance becomes meaningfully comparable for the central government by implementing a yardstick competition mechanism. In this case it can reduce local governments' scope to draw additional grants from the common pool by choosing an untruthful policy. The transfer received by local governments would be a function not only of their own policy measures but also of the performance of neighboring regions. From a game theoretically perspective, an appropriate federal transfer mechanism generates a game in which local governments compete for a bonus payment. Here, the federal government can exploit the fact that self-interested jurisdictions do not internalize the informational externalities on neighboring jurisdictions when they pursue local policy measures. In particular local governments do not take into account that their policy measures serve as a signal for correlated types of neighboring jurisdictions. Therefore, the central government can learn more about local circumstances without offering information rents. In the second step we show that the yardstick competition mechanism may provide positive incentives for local precautionary incentives with implications for the finding of the fourth chapter.

1.4.4 Tax Base Equalizing and Incentives

Tax base equalizing grants entail a tax back effect that internalizes fiscal externalities: an inflow of mobile tax bases induced by tax dumping coincide with a reduced entitlement to benefit from equalizing grants. Nevertheless, tax sharing can undermine local tax incentives if jurisdictions have some latitude of discretion to enforce taxes. Unobserved by the central government, jurisdictions choose inefficiently lax enforcement policies in order to substitute tax revenue

for higher grants-in-aid. Here, we designed truthful transfer mechanisms equalizing tax base differences and equally providing optimal tax incentives. In order to allow for separation of informational types, the second best optimal grants include an information rent as well as a two-way distortion, which differs from standard models.

1.4.5 Internalizing Interregional Spillovers

An effective policy scheme to overcome the suboptimal low provision levels of global public goods is developed in this paper. By suggesting a decentralized approach to raise environmental public good provision levels we take account of the lack of a coercive global authority that is able to enforce efficient international environmental regulations. In our model individual regions voluntarily commence international negotiations on public good provision, which are accompanied by side-payments. These side-payments are financed by means of regional externality-correcting taxes. Side-payments and national tax rates are designed in a mutually dependent way. The decentralized scheme we recommend for approaching Pareto efficient Nash equilibria is based on the ideas of Coasean negotiations and Pigouvian taxes. As it is implementable for a wide class of Nash solutions, it is applicable to various international externality problems.

Chapter 2

Transfers and Incentives in Fiscal Federalism

In this chapter our main concern is to justify the model-theoretical approach which is used in the following study while giving a survey of related articles on the theory of federal transfers. Further I will give a more detailed explanation for why local governments may have better knowledge about region-specific circumstances than the federal level. Moreover we are going to describe the intuitional arrangements of transfer systems in federal states around the word and describe the legal basis.

2.1 Community preference model

In line with Wildasin (1989), Gramlich (1968), Wilde (1968), Oates (1972) and many other recent contributions to the literature of fiscal federalism we consider the simplest model of local public expenditures - the so-called community preference model. Thereby identical households inhabit each region in the federation so that we can boil down the model and a community can be treated as a single household. In this case utility maximizing of the representative household would be equivalent to the maximization of a *Benthamite* social welfare function. In general this framework emerges as a good starting point for theoretical work and it is also the foundation of many theory-based estimations. However throughout

the analysis we always keep in mind that jurisdictions may entail heterogeneous households in real word applications. In particular, there is a limited set of policy measures available to governments when reallocating resources from the private to public sector or correcting market failures. For instance raising a head tax at the local level would solve the problem of interregional fiscal externalities. However, head taxes may be unenforceable in a democratic decision making process in regions with income disparities because of its regressive impact, see Wilson (1999).

2.2 The mainline theory and the new political economy

In order to investigate fiscal decentralization we consider a basic model that Oates (2005) has called the mainline theory of fiscal federalism. As already mentioned we assume that local governments are locally benevolent, i.e. they maximize the welfare of local households, whereas the central government intends to maximize overall federal welfare. Thereby we implicitly assume that democratic institutions are strong and good enough to align the objectives of local decision makers. In particular households can elect decision makers on the local and federal level. Voters will support those politicians who maximize local welfare and throw out of office self-interested politicians. Roughly speaking, this view of a federal state is reminiscent of the work of Musgrave, Oates, and Samuelson, who have modeled the government as a benevolent social planner.

The political economy approach attempts to model the behavior of governments in a more detailed way, as it is done in the standard approach, taking into account delegation problems of politicians when the voting process is not optimal due to informational asymmetries or shortfalls with respect to the constitutional design. In particular, the new political economy approach points

out benefits of decentralization which has not been mentioned in the literature reminiscent of Musgrave, Oates, Samuelson. The scope for rent-seeking can be limited if government functions are assigned to the local level. It is shown that a Leviathan government which takes bribes, or acts in the interest of a special interest group, can be tamed as decentralization increases the accountability of politicians or balances policy measures though horizontal competition; see Brennan and Buchanan (1980), Lockwood (2008), Persson and Tabellini (2000), Besley and Coate (2003). Furthermore it tries to explain why local governments may better match region-specific preferences of households than a central government.

In this study we draw a positive picture from the democratic process assuming that the cost of collective decision making is not too high. Although it deals here with two opposing strands of literature, our investigation does not necessarily stand in contrast with the new political economy approach since it mainly focuses on incentive problems of local governments in the presence of a federal transfer system. Similar to the new political economy approach we investigate rent-seeking behavior of local government authorities in the presence of informational asymmetries. From the viewpoint of the federal government local government are rent seekers who try to draw additional grants from the common pool. In this spirit, both schools of thought draw rather the same picture whereas only the motif of rent seeking may differ.

2.3 Informational Asymmetries in Federations: Theory and Evidence

The literature falls short of delivering an integrated explanation of the information problem predominant in federal states. Thus, in this section, I would like to bring together the different aspects of the literature justifying why informational

asymmetries may be an important problem in federal states. Hayek (1945), Cornes and Silva (2002), and Oates (2005) have pointed out that local governments may better estimate the region-specific costs of public good provision than the central government because they have better access to local information. It is assumed that local government can better estimate region-specific circumstances and can better estimate the preferences of local households because of their proximity to on-site problems. They assume that there is a strong relationship between the ability to gather information and the geographic location of the administration.

What is the reason for an informational advantage of those who are nearer to the problem? It might be plausible that local governments have special skills due to the management of public expenditures, the provision of public facilities as well as raising and administering tariffs or taxes. Dafflon (2008) points out that the information advantage "... is not ipso facto a guarantee of efficiency in the production of the functions that are to be decentralized. To satisfy the demand, governmental authorities cannot be simply 'local', they have to be 'managerial'." What are managerial abilities? Wallis and Dollery (2002) emphasize the importance of social capital in local governments. In general local decision makers have an important outside social network including citizens or professional groups like business organizations. Typically in settings where social networks are in place the cost of gathering relevant local information is reduced. Local decision makers may get updated about the local situation by informal contact networks, characterized by reciprocity and trust, as Wallis and Dollery (2002) have pronounced.

Moreover Dafflon (2008) points out the local governments may lose their competence to provide certain local public goods in the absence of managerial and organizational abilities. Therefore they have a strong interest to invest in

information gathering. The central government may have fewer incentives to acquire local information and to get familiar with region-specific particularities. It mainly uses local data to audit regional governments or to determine conditions of entitlement for transfer payments. As local state verification is costly for the central government it will trade off between the benefits of detecting the local governments' non- truthful policy choice and the cost of auditing (see Gale and Hellwig (1989) for a formalization of the optimal audit problem). In this spirit the central government's ignorance of local types is rational if costs are relatively high as Cremer et al. (1996) suggest.

There might be another aspect in the literature, which supports the fact that local governments have important managerial capacities and hence some informational advantage. Some papers have pronounced that decentralization of the public services may encourage social experimentation as a way to introduce new policies and modernize the public sector. We can treat local governments as laboratories for new policy measures. In a favorable competitive framework local governments invent new policy measures and adopt the best practices from neighboring regions. Due to this evolutionary process whose main output is the discovery of new policies, local governments may have a significant informational advantage concerning the adoption of new specific technologies in local public services compared to the central authority, see Vanberg and Kerber (1994), Breton (1996).

Further, it is interesting to ask if it is possible for an organization with several decision makers, such as a regional government, to hide relevant data when interacting with higher-level governments or with neighboring regions? In the case of an incomplete delegation of the local governments' personnel, privately known information may spill over unintentionally to the central government au-

thorities. The central government may initiate a cloak-and-dagger in order to identify the local information at low cost. Cloak-and-dagger may be a good tool to learn relatively simple data however it may be an unappropriate way to solve the problem if the relevant information encompasses relatively complex data about socioeconomic, cultural, and technological circumstances, which cannot be learned simply. For simplicity in this study we consider a highly stylized model, which illustrates the information asymmetries by a single parameter. In the real word local authorities privately know about a flood of data and it is hence an art in itself for decision makers to evaluate such data.

Moreover it should be taken into account that the incentive problem in this study is not a delegation problem in the strict sense as it is defined in the theory of industrial organization or the theory of procurement and regulation; see for example Tirole (1988) and Laffont and Tirole (1993). Constitutional law in general gives the legal foundation for the federal insurance and predetermines the main goals of a federal transfer system. Hence, in a broader sense, the federal government is actually delegated by the federation as a whole to redistribute tax revenues among governments and insure regions against negative shocks. To make the difference clear let us consider a typically I-O problem where a firm intends to delegate a business service to a subcontractor. For this purpose the firm is offering a contract to the subcontractor. Knowing the technology type of the subcontractor, the firm can offer a contract, which fully extracts the producer's rent so that the incentive-compatibility constraint is binding. This simple setting is sufficient if the firm simply observes the technology type as the subcontractor accepts all contracts meeting the individual-rationality constraint. As already indicated above the setting in federal states slightly differs from the simple I-O model, as the federal government must fulfill an insurance constraint, which is

predetermined by constitutional law. Here, the central government must attest to verifiable data in the constitutional court if there is a dispute with the local government. The quality of information is therefore very high and hence it is less likely that verifiable information will spillover unintentionally to the central authority.

2.4 Mechanism design approach in fiscal federalism

If local governments privately know exogenous parameters the central government faces a typical adverse selection problem: Local governments act in the interest of local households by choosing an option which maximizes local welfare and ignores overall efficiency considerations. Choosing an untruthful local policy, local governments may shift the burden of financing public services onto the federation as a whole. In this study we use a mechanism design approach in order to investigate the main characteristics of transfer schemes, which tackle common pool fishing in a federal state.

The revelation principle ensures that there is no loss of generality in restricting the federal government to offer simple menus of transfer, having options for all types of the specific type space. The direct revelation mechanism offered by the central government can be expressed as a simple message game, in which the federal government commits to pay a transfer and to ask for a local policy enacted by local governments. Both the transfer and the policy measure depend on the information type which is reported as a message by the local government to the central government. In particular we search for incentive-compatible direct mechanisms i.e. for transfer schemes where truthful behavior is the best response in the Bayesian game. The revelation principal tells us that any allocation rule obtained by such a message game can be implemented with a truthful direct revelation mechanism; see Gibbard (1973), Green and Laffont (1977), Myerson

(1979). In a second step we can calculate an indirect transfer mechanism that normally depends on observable policy measures chosen by local decision makers such as tax rates or total tax revenue.

Due to the standard principal-agent literature it often suffices to analyze the optimal contract for just one agent and then aggregate the problem into a multi-agent contract. Moreover the literature on optimal redistribution schemes is vast and dates back to the analysis of an optimal income tax system by Mirless (1971). As a distinctive feature of this study we consider a framework in which local governments interact with each other in many dimensions. This may have important implications for the incentive-compatibility constraint. In particular we show that local governments' competition for mobile capital and some transboundary spillover effects of public service provision may alter the design of the optimal transfer mechanism. Bordignon et al. (2001) pronounce that "... the inefficiencies of the redistribution are potentially more devastating when it is carried out at the level of the regional government rather than among individuals". But we will show that the interdependencies between local governments may be also beneficial as it sometimes allows for a better selection of informational types if policy instruments are endogenously determined.

Inman (2003) and Oates (2005) have pronounced that a simple principle-agent approach has a limited application in the theory of fiscal federalism. If we consider a principal (central government) delegating some service to local administrative units the framework of the model misses out that regional governments have an electoral and fiscal autonomy. Likewise, Inman (2003) calls this strand of literature administrative federalism as it mainly investigates a "government by contract" which may be relevant for regulating different administrations units in a federal state. In contrast, the transfer mechanism, which is going to be

analyzed in this study, should not limit the autonomies of local decision makers. The purpose of this study is to design transfers which tackle the common pool fishing problem predominant in federal states. Local governments can self-select a transfer-policy bunch from a menu offered by the central government preserving local governments autonomy at any time. Indeed the well functioning of a federal transfer system is essential in order to fulfill the principle of connectivity of the exercises and responsibility of government functions.

2.5 The equity argument in federal states around the world

Risk-sharing arrangements, a guarantee of a minimum living standard or the reduction of horizontal imbalances are often embedded in constitutional or higher law. In general the central government intends to achieve fiscal equity, guarantee a minimum standard of public services, assure a minimum welfare level or share interregional risks among local governments, see Boadway (2008). Transfer mechanisms may have different conditions of entitlement. Most commonly, we find revenue sharing programs, equalization transfers over revenues or equalization transfers over needs. The so-called *Länderfinanzausgleich* in Germany is a revenue sharing program among provincial states. Here, a part of the tax revenue from the value added tax collected in provincial states is shared on a per capita basis: the entitlement to benefit from grants depends on the difference between the local per capita tax revenue and the average per capita tax revenues of all provincial states. [1] For a more detailed description of the revenue sharing program, see for example Huber et al. (2002). In Canada the so-called relative tax system is in place to act as an equalizing transfer over revenues on

[1] Here we refer to the vertical fiscal imbalance, so that only a part of the tax competition is shared across regional governments. The value added tax is a community tax, so that a part of the tax revenue is devoted to the central government.

the basis of the relative size of the local tax base, see Smart (1998). A similar tax base-equalizing grant is in place in Germany on the level of provincial states, which equalize disparities among municipalities *(Kommunaler Finanzausgleich)*, see Kuhn (1991, 1995). In South Africa the central government offers an equalizing transfer over fiscal needs for provincial states, see Brosio (1995). Similarly, in China the central government pays federal grants to provinces, which are based on the costs of local public good provision, see Ahmad (2004). Further in Australia we find a transfers scheme, where the payments depend on the relative costs of public good supply predominant in provincial states, see Ahmad and Searle (2008). Moreover we find many risk-sharing programs in many federal states like the federal transfer payments to the US state Louisiana after Hurricane Katrina. In this study we refer to transfer schemes which equalize disparities over fiscal needs and tax base equalizing grants. Moreover, we model risk-sharing programs which should provide financial aid after a negative technological shock has taken place.

Chapter 3

Beneficial Tax Competition[1]

3.1 Tax Competition and Screening Informational Types

A central message of the literature on the efficiency properties in a federal state is that interregional competition is wasteful if local governments are assumed to be benevolent in the Pigouvian tradition. In particular, it is assumed that jurisdictions are locally benevolent in the sense that they act in the interests of their own inhabitants. Jurisdictions that maximize local welfare may engage in competition for common resources not taking into account overall federal welfare considerations. Intrinsically, recent literature has pointed out that competition between governments for mobile capital results in a *race to the bottom* and competition for transfers will lead to *common pool fishing*.

In the introductory chapters 1 and 2 we have already exposed in detail that local governments may estimate the region-specific costs of local public goods provision better than the central government as local decision makers are more familiar with region-specific circumstances. Accordingly, local governments may choose an untruthful policy in order to gain higher grants-in-aid. That is why the federal government cannot peg transfer payments directly on local characteristics. Likewise we describe a scenario throughout this chapter in which local governments are better informed about region-specific data than the central gov-

[1]This chapter has been taken from Altemeyer-Bartscher and Kuhn (2006a/2009).

ernment is. In this case local governments have some latitude of discretion to overfish the common pool by strategically choosing local tax policy, substituting higher grants-in-aid for tax revenue.

As conventional wisdom it is argued that tax competition and common pool fishing are complementary problems contributing to an even more severe one. The reason is that local governments can reduce their tax burden by relying on grants instead of tax revenue and gain a competitive advantage in the tax competition game and attract more capital at the same time. However in this chapter we contrast this insight showing that tax competition may be beneficial as it may tame transfer competition. This is even true for locally benevolent jurisdictions.

What is the background of transfer competition? Local governments try to choose policy measures in order to be eligible for additional grants by mimicking regional type with higher fiscal needs. For this reason the federal government must offer an incentive-compatible transfer mechanism that takes informational constraints into account in order to meet redistributive as well as allocative objectives. In the frame of the game we expect that the central government must then offer positive information rents to induce local governments to truthfully reveal their types. As information rents must be paid additionally where more productive regions gain more than less productive types, fiscal disparities cannot be fully equalized.

As a novel feature in fiscal federalism, we show that tax competition may have an informational content providing for a better selection of informational types. The reason for this result is the following. In regimes with tax competition it turns out to be less attractive to jurisdictions to follow the usual strategy of understating their true technology types. Otherwise, they would have to mimic

a disrupted goods structure which entails a welfare loss. Therefore, the central government is enabled to draw information from the tax competition game and to update its Bayesian beliefs on the informational types involved. This in turn allows for a partial resolution of the adverse selection problem. In this way, some information rents can be extracted, resulting in a higher degree of fiscal equalization because normally rich regions would earn even more information rents.

By the application of the revelation principle we are able to restrict the search for an optimal transfer schedule to truthful direct revelation mechanisms. Such a mechanism entails a menu of transfer payments combined with a tax policy contingent on the informational types reported by local governments. In a second step, we design an indirect transfer scheme contingent on local policy decisions as it can be habitually found in real world applications. Accordingly, in the second best solution, the federal government trades off its desire for the compensation of fiscal externalities against its request for the equalization of local welfare levels.

In a sense, the outcome of the tax competition game synchronize with the optimal Bayesian mechanism such that tax competition (besides its distortionary impact) has a welfare enhancing effect: we make use of the fact that the intensity of local tax competition crucially depends on the region-specific technology types. In particular, less productive (below the top) local governments engage in tax competition more intensively than more productive neighbours (at the top). This is exactly what the second best Bayesian mechanism does: it is going along with increasing distortions of tax incentives for regions below the top and no distortion at the top.

With respect to related literature, first of all, we should mention a number of seminal studies namely Oates (1972), Zodrow and Mieszkowski (1986), Wilson (1986), and Wildasin (1989), in which the problem of tax competition has been

treated, all within the frame of a complete information setting with symmetric jurisdictions. Like in this chapter, Bucovetsky (1991), DePater and Myers (1993), and Peralta and van Ypersele (2002) derive a Nash equilibrium from asymmetric tax competition games. In both of the latter papers, regions differ in population size while our paper regions differ in technological types. Moreover, based on best response functions which crucially depend on region-specific types, we can derive a condition in order to sort informational types which goes beyond the literature mentioned above.

From another point of view, tax competition emerges as beneficial in this chapter as it limits to some extent local governments' scope to overfish the common fund. Thus, tax competition can help in tackling a conflict between local government interest in local welfare on the one hand and overall welfare and efficiency on the other. In a similar way, Brennan and Buchanan (1980) argue that tax competition can limit the taxing power of Leviathan-type governments. In regimes with tax competition, selfish behavior of local governments, e.g. the maximization of attainable budgets, is restrained. So, Leviathan models consider a delegation problem between selfish policy makers and voters within a region while in this chapter the focus is on the conflict of interest between regional governments where politicians are locally benevolent.

Besley and Smart (2002) show that tax competition can enhance welfare as it may increase voters' ability to detect bad incumbent politicians. Local governments change the spending policy in a way that bad politicians are detected with a higher probability. Different from the conventional results predominant in Leviathan models, we learn from Besley and Smart (2002) that it is important to take the effects of fiscal constraints on the behavior of voters as well as politicians into account. In line with our results, the authors show that tax

competition enables a better selection of non-observable local decision makers' ability parameters.

This chapter should contribute also to the literature of federal redistribution with an information economics approach such as Cornes and Silva (2002, 2003), Bucovetsky et al. (1998), Lockwood (1999), Bordignon et al. (2001), and Huber and Runkel (2006). Intrinsically, we learn from this strand of literature that the transfer mechanism in a federal state widely differs from the standard principal-agent approach as one has to take into account strategic interactions between different levels of government as well as interactions among jurisdictions on the same level. In this respect we show that horizontal strategic interaction of local governments, in the form of tax competition, may allow for Bayesian updates by a higher level government. These papers show that local governments are linked together with each other through the mobility of capital , spillover effects, as well as treasuries. The novel contribution of this study is that we try to give an integral analysis of the different backgrounds of interregional competition highlighting the informational constraints.

There also is a link to the literature on yardstick competition which is analyzed in some recent papers such as Besley and Case (1995), Boarnet and Glazer (2002), Kotsogiannis and Schwager (2006). Yardstick competition enables voters or a central government to compare the tax policies of a given region with a similar neighbor. In this case, local policy is more accountable as tax policy pursued in neighboring regions serves as a benchmark - we will get back to the phenomenon of yardstick competition in chapter 5. The informational value of tax competition is of a quite different nature: The central government anticipates that local governments engage in competition for mobile resources and update its beliefs on informational types contingent on the current policy measures.

With respect to empirical evidence, two papers confirm the hypothesis that local governments try to substitute higher grants-in-aid for tax revenue. Baretti et al. (2002) perform empirical tests confirming this hypothesis in the case of higher-level federal grants. Büttner (2006), for the case of Germany, is testing municipalities' tax policies and finds evidence for the aforementioned incentive problem. In a micro-based estimation, Bergstrom et al. (1983, p.1188) find that the costs of school education are difficult to estimate for outsiders. This fortifies our assumption that some cost parameters are private information and can hardly be observed by higher level government.

The chapter outline is as follows. Section 3.2 sets out the basic model. In section 3.3 we define the optimal transfer scheme in the full information case. This may serve as a benchmark for the results of section 3.4, where we turn to the case of asymmetric information. Here we analyze the optimal trade-off between efficient provision of local public goods and the extraction of information rents depicting the benefits of tax competition. Section 3.5 concludes the results of the chapter.

3.2 Model and Problem

3.2.1 Local government policy

We consider a federation composed of a federal government and a large number of local jurisdictions, indexed by $i = \{1, 2, ..., n\}$. Each jurisdiction is endowed with an inelastic supply of one unit of a fixed factor, hereafter referred to as labor. The total capital stock in the federation $\bar{K}$ is exogenously given and capital is perfectly mobile across jurisdictions, so that capital in each jurisdiction earns the same net return r. The production technology exhibits constant returns to scale and is represented by a homogeneous production function. The output expressed

in intensive-form is $f(k_i)$, ($f_k(k_i) > 0$, $f_{kk}(k_i) < 0$, $f_{kkk}(k_i) > 0$)[2] when k_i units of capital and one unit of labor are employed. In order to finance the provision of local public goods each local jurisdiction can raise a unit tax, denoted by t_i, on capital employed in jurisdiction i. Preferences of a representative household in region i are characterized by the following quasi-linear utility function

$$U_i \equiv U_i(x_i, z_i) = z_i + V_i(x_i), \tag{3.1}$$

where x_i denotes private goods consumption and z_i denotes public goods consumption. A local jurisdiction's objective is to maximize the utility of the representative household.

The price for private goods is set equal to unity and the cost of public goods supply is given by $\frac{1}{\theta_i}$. Jurisdictions face different provision costs because of region-specific technological characteristics. We define a profile of technological types $\theta = \{\theta_1, \theta_2, ..., \theta_n\} = \{\theta_i, \theta_{-i}\}$. Types are independently drawn from a commonly known joint distribution on $\times_{i=1}^{n}[\theta_L, \theta_H]$ with $\theta_H > \theta_L > 1$, $\theta_i > 1/p(\theta_i)$, with a cumulative distribution function $P(\theta_i)$, and a density function $p(\theta_i) > 0$ on $[\theta_L, \theta_H]$. Further, the monotonous hazard rate condition is fulfilled, i.e. it applies that $\frac{1-P(\theta_i)}{p(\theta_i)}$ is non-decreasing in θ_i.

We assume that the federal government is able to observe neither technological characteristics θ_i nor the amount of public goods provision at local level. In general, local governments may better estimate region specific cost types than a central government as local governments are more acquainted with on-site problems, see e.g. Oates (2005), and Bordignon et al. (2001). Moreover, the central government cannot usually ascertain the purpose of local governments' expenditures. Referring to the German federal equalizing system, Rodden (2001) points

[2]We assume that marginal productivity is a convex function of the capital employed in a jurisdiction i. Laussel and Le Breton (1998) show that this is a sufficient condition for the existence of a unique pure Nash equilibrium in the tax competition game, which is derived in the following section.

out that it is relatively easy to re-label expenditures designed for another purpose. For the sake of clarity, we consider an economy in which one local public good is provided by each jurisdiction. But, in real world economies in which local governments provide a variety of different public goods, it is difficult to detect the exact purpose of public expenditures. It is, for example, difficult to quantify "school education" if local governments can re-label expenditures for other purposes. Observing only tax rates t_i, the federal government cannot learn anything about local technology types.

Factor markets are perfectly competitive and production factors are thus priced at their marginal productivity:

$$f_k(k_i) = r + t_i \qquad \text{and} \tag{3.2}$$

$$f(k_i) - k_i f_k(k_i) = w_i, \tag{3.3}$$

where $r + t_i$ defines the user cost of capital with interest rate r. The price for the fixed factor in region i is given by w_i. The representative households' total income is composed of wage income and capital income. We assume that the representative household in a region owns an equal share of capital $\frac{\bar{K}}{n} = \bar{k}$ and is spending the whole income on private good consumption, such that $x_i = f(k_i) - (r + t_i)k_i + r\bar{k}$. The local government's budget constraint is given by $t_i k_i + s_i = \frac{z_i}{\theta_i}$, where s_i is a federal transfer received by jurisdiction i. The factor demand in jurisdiction i is given by the inverse of the marginal product of capital $f_k(r + t_i)^{-1} \equiv k_i(r + t_i)$ with $k_i'(r + t_i) \equiv \frac{\partial k_i(r+t_i)}{\partial(r+t_i)} = \frac{1}{f_{kk}(k_i)}$.

At the Walrasian equilibrium, factor prices adjust to clear markets, i.e. $\sum_{i=1}^{n} k_i = \bar{K}$. Therefore, a change in the unit tax on capital t_i implies a change in the net return of capital by

$$\frac{\partial r}{\partial t_i} = -\frac{k_i'(r + t_i)}{\sum_{j=1}^{n} k_j'(r + t_j)} < 0^3. \tag{3.4}$$

[3] As the federal capital stock is exogenously given and the capital market is cleared, it applies

Furthermore, from equation (3.4) it follows that

$$\frac{\partial k_i}{\partial t_i} = \frac{1}{f_{kk}(k_i)}\left(1 + \frac{\partial r}{\partial t_i}\right) < 0 \qquad \text{and} \qquad \frac{\partial k_j}{\partial t_i} = \frac{1}{f_{kk}(k_j)}\frac{\partial r}{\partial t_i} > 0. \tag{3.5}$$

Expectedly, increasing t_i some capital flows out of jurisdiction i and is employed in other regions.

3.2.2 Central government policy

A minimum welfare level denoted by U^0 is guaranteed to each jurisdiction by constitutional law. In the frame of this model the welfare guarantee U^0 is exogenously given. We assume that for this purpose the central government can offer grants-in-aid s_i, not necessarily positive, to local governments before local tax policies are set. The objective of the federal government is to choose a transfer mechanism that minimizes *total transfer payments* necessary to concede U^0 to any jurisdiction. To describe a meaningful setting we assume that the central government should provide the opportunity that local governments can achieve the welfare level U^0. Therefore the insurance constraint is here met if local governments may attain the welfare level U^0 by enacting an appropriate local policy within a budget period. Moreover, the minimization problem can be interpreted as a dual problem to the maximization of the welfare guarantee subject to the funds given. Formally, the federal government's policy can be expressed by the following minimization problem:

$$\min_{t_1,\ldots,t_n,s_1,\ldots,s_n} \sum_{i=1}^{n} s_i \tag{3.6}$$

$$\text{s.t.} \qquad \theta_i\left(k_i t_i + s_i\right) + V_i(f(k_i) - (r + t_i)k_i + r\bar{k}) \geq U^0. \quad \text{for all } i. \tag{3.7}$$

Naturally, the optimal transfer mechanism will crucially depend on the information structure given, in particular on whether θ_i is common knowledge or not.

that $\frac{d\bar{K}}{dt_i} = 0$ and hence $k_i' + \sum_{j=1}^{n} k_j' \frac{\partial r}{\partial t_i} = 0$. Further we assume that capital holders can get rid of their capital at no cost, so that $\frac{\partial r}{\partial t_i} \geq -1$.

3.2.3 The timing of the game

We model a multi-stage game in fiscal federalism with strategic tax competition among local governments at the second stage and the design of incentive-compatible federal transfer schemes at the first stage. The timing of the game is as follows:

- At *stage 0* local jurisdictions learn their types $\theta_i \epsilon [\theta_L, \theta_H]$.
- At *stage 1* the federal government offers a transfer scheme contingent on local tax policies.
- At *stage 2* the tax competition game takes place and local governments strategically choose a tax rate on capital.
- At *stage 3* local jurisdictions receive the grants-in-aid.

3.3 Full Information Policy

In this section as a benchmark, we would like to analyze central government policy in the case of full information if technology parameters θ_i are common knowledge and tax policy t_i is observable. In this case, the federal government can implement an optimal local tax policy by an appropriate two-part transfer. In line with Wellisch (2000) and Wildasin (1989), fiscal externalities can be fully corrected by a Pigouvian subsidy, whereas fiscal disparities among local jurisdictions can be fully equalized by a lump-sum grant.

Before we turn to the design of optimal grants-in aid offered by the federal government, we investigate the behavior of local governments. At *stage 2*, tax competition generates the following normal form game:

$$\Gamma = \{N, (S_i)_{i \epsilon N}, (U_i)_{i \epsilon N}\},$$

where $N = \{1, 2, ..., n\}$ is the set of jurisdictions and $S_i = t_i \epsilon \Re_+$ the set of tax strategies of i. The third element is the sequence of local government pay-offs, which we have defined in equation (3.1).

A number of n jurisdictions is competing for mobile capital by a strategic tax policy decision. Local jurisdictions are aware of the federal transfer scheme, which has been offered by the federal government at the previous *stage 1*. As usual the federal government is taken to correctly anticipate local jurisdictions' decisions in their competition for mobile capital. Assuming Nash strategies, a jurisdiction i pursues a local welfare maximizing tax policy t_i, given the tax policy of any of its neighbors t_{-i}. We define the best response function of i, given its specific technology:

$$BR_i(t_{-i}, \theta_i) = \arg\max \theta_i \left(k_i t_i + s_i\right) + V_i(f(k_i) - (r + t_i)k_i + r\bar{k})$$

which entails the following first order condition:

$$\theta_i \left(k_i + t_i \frac{\partial k_i}{\partial t_i} + \frac{\partial s_i}{\partial t_i}\right) + V_x(x_i) \left(\frac{\partial r}{\partial t_i} \left(\bar{k} - k_i\right) - k_i\right) = 0 \quad \text{for all } i.$$

or equivalently:

$$1 = \frac{MCF_i(t_i, t_{-i})}{\theta_i} \tag{3.8}$$

At the optimal level of public good supply, the marginal willingness to pay for z_i of a representative household is set equal to the economic cost of taxation in terms of private good consumption. The LHS in equation (3.8) signifies the marginal benefit of public good provision z_i, which is equal to unity here. The RHS denotes the household's contribution to finance the costs of an additional unit of public goods, hereafter referred to as the marginal cost of public funding (MCF_i), weighed by the productivity parameter θ_i. The marginal cost of public funding adds up to:

$$MCF_i(t_i, t_{-i}) = \frac{V_x(x_i)\left(\frac{\partial r}{\partial t_i}\left(k_i - \bar{k}\right) + k_i\right)}{(k_i + t_i\frac{\partial k_i}{\partial t_i} + \frac{\partial s_i}{\partial t_i})} \tag{3.9}$$

Obviously, a local government takes into account the opportunity cost of a lower private goods consumption coinciding with a tax increase. It further internalizes the negative impact of an exodus of the mobile tax base on both private and public good consumption. Moreover, it anticipates the marginal effect of its tax policy on the federal transfer payment $\frac{\partial s_i}{\partial t_i}$. However, regionally benevolent jurisdictions only consider fiscal effects that impacts *local* welfare. External effects induced by a tax policy change on other jurisdictions are not internalized as is demonstrated below.

Concavity of local welfare functions implies that the best response functions are single-valued and the n equations with n unknowns yield a unique Nash equilibrium: $t_i \epsilon BR_i(t_{-i}, \theta_i)$ for all $i \epsilon N$. Due to the negligence of fiscal externalities the Nash equilibrium in the tax competition game involves an inefficient local tax policy in the form of tax-dumping and therefore calls for federal correction.

In physical terms, a jurisdiction of type θ_i can transform one unit of a private good into θ_i units of a public good. Consequently, the marginal economic cost of taxation *in terms of* private good consumption, denoted by $\frac{MCF_i}{\theta_i}$ is less important for regions with a high efficiency parameter. Thus, they have a higher willingness to tax capital than less efficient neighbors.

Lemma 1 *In the Nash Equilibrium high-type (low-type) regions have a high (low) willingness to tax capital.*

$$\theta_i > \theta_i' \quad \Longrightarrow \quad BR_i(t_{-i}, \theta_i) > BR_i(t_{-i}, \theta_i') \quad \textit{for all } i.$$

Proof *see Appendix*

Let's now turn to the federal government's problem. At *stage 1* the federal government anticipates that jurisdictions will engage in tax competition at *stage*

2. It offers a transfer scheme minimizing cumulative transfer payments to meet welfare guarantee U^0 as well as to restore overall efficiency. Using equations (3.6) in (3.7), yields the following optimization problem.

$$(t_1^*, ..., t_n^*) = \arg\min \sum_{i=1}^{n} \{U^0 - V(x_i) - z_i\}. \tag{3.10}$$

$$\text{s.t.} \quad (3.2) \quad \text{and} \quad (3.3)$$

Intuitively, the federal government minimizes the gap between guaranteed welfare and the actual performed local welfare. The gap is negative if a local government is a net contributor to the federal transfer system. The first order conditions of the minimization problem are:

$$\begin{aligned} &\theta_i \left(k_i + t_i^* \frac{\partial k_i}{\partial t_i} \right) + V_x(x_i) \left(\frac{\partial r}{\partial t_i} (\bar{k} - k_i) - k_i \right) + \\ &\sum_{j \neq i} \left(V_x(x_j) \frac{\partial r}{\partial t_i} (\bar{k} - k_j) + \theta_j t_j^* \frac{\partial k_j}{\partial t_i} \right) = 0, \quad \text{for all } i. \end{aligned} \tag{3.11}$$

or equivalently:

$$1 = \frac{SMCF_i(t_i^*, t_{-i}^*)}{\theta_i}, \quad \text{for all } i, \tag{3.12}$$

where the RHS denotes the *social marginal cost of public funding* ($SMCF_i$) in terms of private good consumption in region i. The social marginal cost of public funding includes the positive external effects of a tax exodus from region i to its neighbors. The latter term in equation (3.11) expresses the total sum of external effects across all neighboring jurisdictions, which reduces the true economic cost of taxation. Hence, in the absence of central government intervention, the *perceived* marginal cost of public funding (MCF_i) exceeds its *social* marginal cost ($SMCF_i$). Consequently, local governments raise inefficiently low taxes on mobile capital and therefore under-provide local public goods.

The central government can internalize the positive marginal effects of a capital outflow on neighboring jurisdictions by offering a Pigouvian subsidy $b_i(\theta_i)t_i$ to each jurisdiction i. In line with Dalby (1996) efficiency supporting matching

rates must satisfy

$$b_i(\theta_i) = \frac{1}{\theta_i} \sum_{j \neq i} \left(V_x(x_j) \frac{\partial r}{\partial t_i} (\bar{k} - k_j) + \theta_j t_j^* \frac{\partial k_j}{\partial t_i} \right). \tag{3.13}$$

The extent to which local governments engage in tax dumping crucially depends on the region-specific technology parameter. Basically, tax competition is a severe problem for local governments, which prefer a high public good supply due to their technology type while a tax cut leads to a relatively low reduction of public good supply in regions with low technology types. Consequently, low-type regions tend to engage in tax competition more intensively than high-type regions. The optimal transfer, which restates overall efficiency must meet this concern so that externality-correcting matching rates must be a decreasing function of the technology type.

Lemma 2 *The matching rate $b_i(\theta_i)$, which fully internalizes the external effects of tax competition, is a monotonously decreasing function in θ_i.*

Proof *see Appendix*

In addition to the matching component, a lump-sum component $a_i = U^0 - U_i(t_i^*, t_{-i}, \theta_i) - b_i t_i^*$ must be paid to guarantee a welfare level of U^0. Put together, the central government offers a transfer scheme of the form:

$$S(t_i) = a_i + b_i(\theta_i) t_i.$$

Proposition 1 *In the full information case, the federal government offers a transfer scheme such that local jurisdictions are fully insured at the level $U^0 = U_i$ for all i, and the external effects of tax competition are fully corrected.*

Finally, it should be noted that in the frame of the model, the optimal allocation of capital and the optimal mix of public and private goods supply may differ from the first best optimal solution, as decision makers have only a limited set of instruments available, which is a tax on mobile capital raised by local governments and a transfer paid by the federal government. Further, the capital

supplied by local households $\bar{k}$ is exogenously given. As we abstract from interpersonal income redistribution, it is impossible to choose the level of private good supply in one region independently of the private good supply in other regions. Hence, the modified Samuelson condition depicts a trades off between an optimal allocation of consumption goods (optimal mix of private and public goods in each region) and production inputs (optimal allocation of capital in the federation); see Wildasin (1989) and DePater and Myers (1992).

3.4 Incentive-Compatible Transfer Schemes

Turning to the case of an asymmetric information structure, we assume that central government can verify neither the technology types nor the locally supplied amount of public goods, but can only observe the tax policy t_i. Thus local governments strategically choose an untruthful tax policy in order to take advantage of this in two respects. On the one hand, the substitution of higher grants-in-aid for tax revenue involves a positive revenue effect through a higher private good consumption. On the other hand, a local government may gain a competitive advantage over its rival neighbors in the tax competition game.

Given such a scenario, in the following we show how central government can provide incentives for an optimal local tax policy and equally can guarantee the reservation welfare level U^0. By the *revelation principle*, we may restrict our search for the best federal policy to direct transfer mechanisms. The direct revelation mechanism entails a menu of transfer payments combined with a tax policy contingent on the informational types θ_i reported by local governments. In a second step, we design an indirect transfer scheme contingent on local policy decisions, which is better applicable in real world examples. However first of all we describe the background of interregional transfer competition by the following

simple message game:

$$\hat{\Gamma} = \{N, (t_i(\theta_i, \theta_{-i}))_{i\epsilon N}, (s_i(\theta_i, \theta_{-i}))_{i\epsilon N}, \times_{i=1}^{n}[\theta_L, \theta_H]\}.$$

To minimize *expected total* transfer payments, the federal level chooses a transfer scheme that provides optimal incentives for local tax effort and at the same time guarantees a minimum welfare level U^0.

$$\min_{t_1,\ldots,t_n,s_1,\ldots s_n} \quad \sum_{i=1}^{n} E_\theta[s_i(\theta_i, \theta_{-i})] \qquad \text{s.t.}$$

$$E_{\theta_{-i}}[V(f(k_i)-(r+t_i(\theta_i,\theta_{-i}))k_i+r\bar{k})+\theta_i\left(k_i t_i(\theta_i,\theta_{-i}) + s_i(\theta_i,\theta_{-i})\right)|\theta_i] \geq U^0, \quad \forall i \tag{3.14}$$

$$E_{\theta_{-i}}[V(f(k_i) - (r + t_i(\theta_i, \theta_{-i}))k_i + r\bar{k}) + \theta_i\left(k_i t_i(\theta_i,\theta_{-i}) + s_i(\theta_i,\theta_{-i})\right)|\theta_i] \geq$$

$$E_{\theta_{-i}}[V(f(k_i) - (r + t_i(\tilde{\theta}_i, \theta_{-i}))k_i + r\bar{k}) + \theta_i(k_i t_i(\tilde{\theta}_i, \theta_{-i}) + s_i(\tilde{\theta}_i, \theta_{-i}))|\theta_i], \quad \forall i, \tilde{\theta}_i. \tag{3.15}$$

Equation (3.14) ensures that the expected welfare of any jurisdiction cannot fall short of U^0. To be accurate we take into account that local governments cannot observe costs types of neighboring regions. Hence, they will themselves form beliefs on the competitive behavior contingent neighboring information types θ_{-i}. Therefore each jurisdictions choose t_i to maximize the conditional expected value of local welfare.[4] Additionally, we have to consider the Bayesian incentive-compatibility constraints (3.15) ensuring that truth-telling for all i and all θ_i is a Bayesian equilibrium of the direct transfer mechanism proposed by central government: given jurisdiction i's belief with respect to the technology types of neighboring regions, it can never be profitable for i to mispresent its type, which means strategy $\tilde{\theta}_i \neq \theta_i$ is never profitable. By the following theorem, we can further reduce the problem:

[4]Here the central government provides opportunities for local governments to attain U^0, if they correctly anticipate tax policy decisions of their neighbors. With a large number of jurisdictions and by the weak law of large numbers the current vector of policies would not differ by a high extent from local governments' rational expectations.

Theorem 1 *Incentive compatible transfers that guarantee at least U^0 to each jurisdiction are:*

$$s(\theta_i, \theta_{-i}) = \frac{1}{\theta_i} E_{\theta_{-i}}[U^0 - V(f(k_i) - (r + t_i(\theta_i, \theta_{-i}))k_i + r\bar{k}) - \theta_i \left(k_i t_i(\theta_i, \theta_{-i})\right) + \int_{\theta_L}^{\theta_i} k_i t_i(\theta_i, \theta_{-i}) d\theta_i^0 | \theta_i]. \tag{3.16}$$

Proof *see Appendix*

To give an interpretation, it should be recalled that local governments strategically cut tax rates by mimicking a less efficient type to be entitled to higher grants-in-aid. The increase in the transfer payment exceeds the welfare loss induced by the tax cut. Hence, the surplus gained by mispresenting data must be outweighed by an additional information rent. The last term on the RHS of equation (3.16) depicts the respective information rent provided to local governments. Therefore, in the incomplete information case the contribution rate of the redistribution system is lower and disparities are not fully equalized. In particular, it is lower if a positive information rent is paid to efficient regions.

Let us consider the tax scheme incorporated in the direct mechanism. The federal government implements a schedule of tax rates $t(\theta_i, \theta_{-i})$ that minimizes *expected total* transfer payments. By using equation (3.16), the expected total transfer payments are given by:

$$\sum_{i=1}^{n} E_{\theta_i} \frac{1}{\theta_i} [U^0 - V(f(k_i) - (r + t_i(\theta_i, \theta_{-i}))k_i + r\bar{k}) - \theta_i \left(k_i t_i(\theta_i, \theta_{-i})\right) + \int_{\theta_L}^{\theta_i} k_i t_i(\theta_i, \theta_{-i}) d\theta_i^0]. \tag{3.17}$$

As the monotonous hazard rate condition is fulfilled, the decision function $t_i(\theta_i)$ is monotonously increasing in θ_i. Integration by parts of (3.17) yields the central

government's minimization problem:

$$\begin{aligned}\left(\hat{t}_1, ..., \hat{t}_n\right) = \arg\min \sum_{i=1}^{n} \int_{\theta_L}^{\theta_H} \cdots \int_{\theta_L}^{\theta_H} [V(f(k_i) - (r + t_i(\theta_i, \theta_{-i}))k_i + r\bar{k}) \\ + \theta_i \left(k_i t_i(\theta_i, \theta_{-i})\right) - \frac{1 - P(\theta_i)}{p(\theta_i)} k_i t_i(\theta_i, \theta_{-i})][\prod_{i=1}^{n} p(\theta_i)] d\theta_n \cdots d\theta_1\end{aligned} \tag{3.18}$$

The first order conditions read:

$$\begin{aligned}\left(\theta_i - \frac{1 - P(\theta_i)}{p(\theta_i)}\right)\left(k_i + \frac{\partial k_i}{\partial t_i}\hat{t}_i\right) + V_x(x_i)\left(\frac{\partial r}{\partial t_i}(\bar{k} - k_i) - k_i\right) + \\ \sum_{j \neq i}\left(V_x(x_j)\frac{\partial r}{\partial t_i}(\bar{k} - k_j) + \left(\theta_j - \frac{1 - P(\theta_j)}{p(\theta_j)}\right)\hat{t}_j \frac{\partial k_j}{\partial t_i}\right) = 0 \quad \text{for all } i.\end{aligned} \tag{3.19}$$

equivalently we can write:

$$1 = \frac{VMCF_i(\hat{t}_i, \hat{t}_{-i})}{\theta_i}, \quad \text{for all } i, \tag{3.20}$$

where the denominator on the RHS signifies the *virtual marginal cost of public funding* (VMC_i), which includes the marginal informational cost $\frac{1-P(\theta_i)}{p(\theta_i)}\left(k_i + \frac{\partial k_i}{\partial t_i}\right)$[5] going along with federal redistribution. For all types $\theta_i < \theta_H$, the hazard function has a positive value so that the $VMCF_i$ exceeds the $SMCF_i$. In Appendix 9.3, we show that there is always an interior solution. Thus, we can state:

Proposition 2 *In a second-best optimal tax policy setting, the external effects of tax competition are not fully corrected for all types θ_i apart from the highest possible type θ_H.*

The intuition behind this result is as follows: A high-type region which wants to draw additional transfers from the common pool must emulate the tax policy of low-type regions. This, however, involves an inappropriate structure of private and public goods provision, which is even more severe in regimes with tax competition. As we may recall from Lemma 2, low-type regions engage in tax-dumping much more intensively than high types. Thus, the welfare loss incurred

[5]The interpretation of the monotone hazard rate function is as follows: Consider the set of $1 - P(\theta_i)$ jurisdictions in the federation, which can provide public goods at least as efficiently as a θ_i-jurisdiction. The conditional probability that a jurisdiction of this set has similar provision cost to the θ_i-jurisdiction, i.e. has a type on $[\theta_i, \theta_i + d\theta_i]$, is given by $\frac{p(\theta_i)}{1-P(\theta_i)}$. With higher θ_i it becomes more probable that jurisdictions of this set have similar cost as the θ_i-jurisdiction.

through the emulation of the tax-dumping strategies of low-type jurisdictions in tax-competition games is indeed higher than in its absence. Therefore we can state:

Corollary 1 *Mispresenting informational cost types becomes less attractive in regimes with local tax competition.*

Anticipating tax competition, the central government can update its Bayesian beliefs with respect to informational types. This enables the federal government to extract some information rents and hence reduce total transfer payments by offering lower matching rates. Consequently, local governments must contribute to the federal redistribution system if they receive lower information rents.

Hence, by allowing for some tax competition, there is a trade-off between the scope for federal redistribution and allocative efficiency. In order to depict the second best optimal transfer policy, we rewrite the implementation scheme as a strictly increasing and convex function of observable local policy decision t_i. Assuming that the central government can observe *total* expenditure levels, we can re-specify the transfer in terms of total expenditures if this would relate more closely to legal regulations in some federal states. Thereby we can reproduce the menu of transfers composed of a lump-sum grant and a matching grant.[6]

$$S_i(t_i) = \hat{a}_i + \left(\hat{b}_i(t_i) - \frac{1 - P(\theta_i)}{p(\theta_i)} \left(\frac{\partial k_i}{\partial \hat{t}_i} \hat{t}_i + k_i \right) \right) t_i, \tag{3.21}$$

where $\hat{b}_i$ is the matching rate that corrects for fiscal externalities in region i, given that all neighbors enact a second best optimal tax policy.

$$\hat{b}_i(\theta_i) = \frac{1}{\theta_i} \sum_{j \neq i} \left(V_x(x_j) \frac{\partial r}{\partial t_i} (\bar{k} - k_j) + \left(\theta_j - \frac{1 - P(\theta_j)}{p(\theta_j)} \right) \hat{t}_j \frac{\partial k_j}{\partial t_i} \right)$$

Firstly, the transfer scheme guarantees a minimum welfare and concedes a positive information rent to induce truth-telling by offering a lump-sum pay-

[6] An elaborate description of indirect incentive scheme for government contracts is given by Reichelstein (1992).

ment. Adding the inverted function $\theta = \theta^*(t)$ (vector t and θ) to the incentive-compatibility and the insurance constraint, the lump-sum payment yields

$$\hat{a}_i = U^0 - U(\theta^*(t)) + \int_{\theta_L}^{\theta_i} \theta^*(t) k_i d\theta_i^0 - \hat{b}_i \hat{t}_i.$$

Secondly, the transfer scheme regulates tax policy t_i by a matching component depicted by the term in parentheses on the RHS of equation (3.21). The difference between the marginal external effects and marginal informational cost of fiscal policy expresses the optimal trade-off where, at the margin, the welfare gain of increased rent extraction and its welfare loss induced by tax competition are balanced.

It is worth investigating the nature of external effects in more detail. By Lemma 2, we know that the marginal external effects of tax competition are a decreasing function in the technology type θ_i. Likewise, the marginal informational costs weighed by the hazard rate $\frac{1-P(\theta_i)}{p(\theta_i)}$ are a decreasing function in θ_i. The extent to which the central government must still offer a system of matching rates crucially depends on the elasticity of the tax base, as well as on the distribution of informational types which are exogenously given.[7]

3.5 Second-Best Optimal Tax Autonomy

Basically, interregional competition in a federal system is bad when local decision makers are good. Regionally benevolent local governments act in the interests of their residents and neglect overall efficiency considerations. Therefore, jurisdictions try to attract capital from neighboring regions and shift the burden of financing local public good supply onto the federation as a whole. As an important result in this chapter, we show that tax competition limits the latitude of discretion to draw additional grants from federal funds. Heterogeneous ju-

[7] The marginal value of b_i and marginal information costs are determined by the elasticity of the tax base.

risdictions react differently in regimes with tax competition, so that the central government can update its beliefs with respect to the local information types. Hence, a more compensatory redistribution scheme can be implemented, reducing fiscal disparities to a greater extent. Thus, we point out a new reason for why local tax competition may improve overall federal welfare.

Due to the second best world represented in the model of this chapter it might be even worth to discuss the assignment of fiscal sovereignty to decentralized governments. If local governments have the power to tax some mobile factors this might be welfare enhancing as we have learned. From the information-based perspective the optimal fiscal constitution of the federal state may assign the power to tax to local governments in an appropriate way to advocate tax competition which approximates the second best optimal solution. Kuhn (1995) and Wilson and Janeba (2005) have put a similar problem up to discussion showing that horizontal tax competition might be beneficial in federations with vertical fiscal external effects, i.e. if more than one government raise taxes on a particular tax base. In this case the race-to-the bottom of horizontal tax competition may countervail the negative vertical tax externalities.

Chapter 4

The Ex-Post Dilemma in Fiscal Federalism[1]

4.1 The Ex-Post Dilemma and Informational Asymmetries

We have already demonstrated that allocative and redistributive disruptions can be fully resolved if the central government can credibly commit ex-ante to a well-defined system of grants composed of lump-sum payments and a scheme of matching rates. In game theory terms the central government acts as a Stackelberg leader offering transfer payments to local governments which then in turn must adapt their policy to the federal grant rule. However, sometimes the central government is not able to credibly commit to a fixed grant rule, but transfer payments get determined ex-post only, i.e. after local governments have chosen their policy. There are many reasons given in the literature and discussed in detail below for why this might be the case. For instance, the federal government might want to step in after a regional breakdown because of interregional spillovers, political competition, and a welfare guarantee, which all may give rise to ex-post transfers.

In this chapter we stress that the ex-post problem is often rooted in an asymmetric information structure between different government levels in a federal

[1]This chapter has been taken from Altemeyer-Bartscher and Kuhn (2009).

state. In general, the local level may be better informed about local characteristics and it might be hard for the federal government to observe the quality of precautionary measures enacted by local jurisdictions in order to reduce the likelihood of future shocks. Likewise the main economic rationale for why the responsibility of precautions investment policy is assigned to the local level lies in the local governments' informational advantage. Further it is the central government's inability to observe local policy measures which may explain why it is so difficult in practice to precisely predefine grant rules contingent on local needs and policy measures. If informational asymmetries are an ultimate cause of the ex-post problem in a federal setting, it should be taken anyhow into account that the underlying information set may have a substantial impact on the local incentives structure of related policy fields. Adopting a rather positive theory view, our main focus in this chapter is to analyze the nature of the ex-post redistribution problem from an information-based perspective.

A common feature of all kinds of ex-post transfer payments is that they may provoke the so-called *Good Samaritan Problem*, introduced by Buchanan (1975). In this approach incentives for the efficient provision of local public goods for consumption as well as for long-term investment get distorted in the presence of federal insurance. Local governments may want to take much higher risks than usual in choosing their long-term policies because the consequences of negative shocks are not fully reflected in their budgets. They are induced to under-invest in precautionary policy measures like the modernization of public infrastructure and public services running the risk of high consequential costs for public goods provision in the future. In general, local governments may try to choose their policy measures strategically to pre-determine federal transfer payments in their favor. In this context the *Good Samaritan Problem* can be interpreted as

a failure if the *Rotten Kid Theorem*. In the frame of the dynamic game local governments provide public policy in two different periods an hence have some degree of freedom to shift a part of the burden on the federation as a whole.[2]

Principally, the literature points out three reasons for the central government's incapacity to commit to a strict transfer rule ex-ante: Wildasin (1997) shows that in the absence of a welfare guarantee under constitutional law the central government's pre-commitment to a fixed transfer rule would not be credible if a regional breakdown may go along with adverse interregional spill-over effects. Persson and Tabellini (1992) as well as Goodspeed and Haughwout (2006) argue from a public choice perspective that a central government maximizing expected votes tends to step in to support jurisdictions after negative shocks. Köthenbürger (2007) mentions that in various federal states like Germany, Switzerland, Canada and South-Africa equal opportunities or an equal living standard across regions are warranted by constitutional law. Therefore the federal government, as in this chapter, is obliged to equalize disparities if local governments face high fiscal needs ex-post.

Commitment to federal insurance does not coercively rule out that the federal government offers co-funding programs within a budget period to provide optimal incentives for long term policy. What should be offered are conditional grants contingent on investment levels in each budget period. In order to meet overall efficiency and resolve the *Good Samaritan Problem* it is important that insurance-payments are given only up to an amount guarantees the desired welfare level. However, in practice federal corrective policy is often found inefficient because of informational asymmetries between the local and the federal level. If some policy measures are non-observable to the federal government, local gov-

[2]For a more detailed exposition of the incentive problem see Bergstrom (1989) and Weibull and Lindbeck (1988)

ernments can easily recast expenditures labeled as investment for other purposes as recent literature has shown.

Rodden (2001) for example points out that the central government can hardly ascertain the purpose of expenditures, because it may be relatively easy to relabel public spending for consumption goods into investment expenditures. Obviously, the true cost of the public good supply must be unknown to the central government, because otherwise it would easily be possible for the central government to compute the share of expenditures used for certain purposes.

However we have already demonstrated in chapter 3 that in this setting local governments are apt to substitute grants-in-aid for higher tax revenue by choosing an untruthful policy. The first problem is one of moral hazard as an endogenous policy measure (local investment) is unknown to the central government. The latter problem is one of adverse selection rooted in unobservable data on local technology types. Both problems are even intertwined in our approach since technology types heavily depend on long-term investment as we will see.

To capture the main features of ex-post redistribution schemes we consider a federal state consisting of a central government and several local jurisdictions. Local public goods are provided by local governments which basically choose two types of policy measures: On the one hand, a long-term policy measure like investment in local infrastructure and modernization of public services which may positively effect the efficiency and the welfare of the region in future periods, on the other hand, short-term public consumption effective within a budget period. Thereby, local governments face a typical investment problem trading off public consumption today and investment in long-term public projects preparing the region for the future. As indicated we describe a framework in which transfers cannot be offered contingent on the investment level or the technology types

as this data is considered unobservable by the central government. Further, any kind of bonus payments rewarding good performance are ruled out since the central government is considered as not being able to commit to bonus payments for long-term investment programs such as flood protection or infrastructure maintenance since they may become effective only after several years or even decades.

In order to understand the nature of the ex-post problem we must determine the expected benefits of long-term policy measures in the presence of a transfer scheme paid after local policy has been enacted. In line with the forgoing chapter we show that the central government cannot fully equalize fiscal disparities because of information constraints. We learn that a high dependency on federal aid limits the latitude of discretion for local governments in other policy fields if the federation is characterized by informational asymmetry. It will become obvious that efficient regions, which take precautions against negative shocks, will have more options for discretionary local policy measures and can gain a discretionary budget.

Local governments' prospects to gain a discretionary budget in future periods may thus provide large-scale incentives for investment in long-term projects. As a result, in a dynamic context, local governments partially become residual claimants of their local policies if less progressive transfers are expected so that the *Good Samaritan Problem* is partly alleviated. From this viewpoint long-term policy can be considered as an investment in higher expected information rents. Therefore this chapter shows that despite the reliance on federal aid,local governments still have strong incentives to pursue a sound long-term policy because it can protect against a full dependence on federal aid.

To which extend may well-prepared regions gain a higher actionability? This depends on the quality of transfer scheme offered by the central government to

tackle the information problem. In this chapter we are going to design the second best optimal transfer scheme. From the positive view of our study it may evaluate the upper bound of the scope for federal redistribution systems: the revelation principle tells us that there is no other class of mechanism with which the central government can achieve a more equational transfer scheme. In this spirit the second best optimal solution can be interpreted as a conservative estimation of the ex post problem in federal states.

Referring to the rebuilding of New Orleans after hurricane Katrina, Becker (2005), Glaeser (2005) and Goodspeed and Haughwout (2006) point out that local governments' decisions would be optimal if they would have to fully bear the social cost of their respective policies in the case of natural disasters. A similar dynamic incentive problem can arise, if local governments make long-term decisions like investment in maintenance of infra-structure as well as in the modernization of public services which affects the wellbeing of the federation beyond the budget-period, see Wurzel (1998). Studying the soft budget problem *inter alia* Kornai et al. (2003), and Wildasin (1997) point out that the central government's incentive to bail out a region arises *ex post*, if the local government cannot fulfill its duties because of a distressed budget.

Persson and Tabellini (1992) analyze the incentive problem of risk sharing programs in federal states. Local governments have to decide on social security insurance and public investment affecting the expected well being of the region in the future. Different to our chapter they study risk-sharing arrangements among collective bodies elected by a median voter. They consider institutional settings with a different division of responsibilities between the two government levels and various implications for the commitment devices for the elected bodies. Intrinsically, local governments' incentives to engage in long-term policy depend on

the commitment devices of the elected bodies with respect to federal insurance.

In a bail-out framework Kaiser (2008) argues that the dependency on federal transfer payments may constrain local governments in other policy fields. Kaiser notices that bail outs in a federation are linked to additional obligations and requirements for the respective jurisdiction. Saving goals and prescribed tax rates reduce the actionability of local governments after a bail-out and hence make common pool fishing less attractive.

The ex-post transfer payments considered in this chapter however differ significantly from ones leading to the common bail out problem. The bail out literature, e.g. Wildasin (1997) and Goodspeed (2002), generally describe a single rescue after a financial breakdown triggered by an unresponsive fiscal policy while we in contrast consider a transfer system for equalizing disparities in every budget period. Further we highlight that in many federal settings the only reason why not all parameters of the grants scheme can be predefined is hidden action in tandem with hidden information.

Intrinsically, the literature has shown that there is no veritable solution for the ex-post problem in federal states. On the one hand it proposes to reduce insurance benefit from federal transfer system so that a lower amount of fiscal commons is at stake. Accordingly Wildasin (2006, 2009) proposes local rainy day funds so that a part of the federal insurance system may be *sourced out* in the area of authority of local governments. On the other hand the literature considers specific institutional arrangements allowing the federal government to credibly threat with sanctions local governments with policy shortfalls. Kaiser (2008) points out that bailouts become less attractive for local governments if federal aid is accompanied by scrutiny reducing the policy makers' capacity. In this chapter we argue that the informational asymmetries are both a primary

cause for why transfers are not well-defined ex ante and and the reason for why local governments may still gain rents in the presences of federal insurance.

With respect to empirical studies two papers confirm the hypothesis that local governments try to substitute higher grants-in-aid for tax revenue. Baretti et al. (2002) perform empirical tests confirming this hypothesis in case of higher-level federal grants. Büttner (2006) tests the municipalities' tax policies and finds evidence for the aforementioned incentive problem. Seitz and Kempkes (2006) pronounce that local governments' disincentives to invest in long-term policy may be an important problem. According to their estimations for the year 2006 East German provincial governments on average deviate 40 per cent of the grants originally dedicated to *infrastructure catching up* to public consumption.

The outline of chapter 4 is as follows: In section 4.2 we describe the basic model. As a benchmark solution we study an optimal ex-ante transfer in section 4.3. In section 4.4 we analyze the incentive problem going along with ex post redistribution and propose an incentive compatible transfer scheme. Section 4.5 concludes.

4.2 Model and Problem

4.2.1 The local government's policy

We consider a federation composed of a central government and a large number of local jurisdictions, indexed by $i = \{1, 2, ..., n\}$. Different to chapter 3 we now consider local governments, which chooses two different types of policy measures: a short-term policy measure z_i and a long-term policy measure y_i. The short-term policy can be interpreted as expenditures for public consumption with a one-period horizon. In contrast, the long-term policy refers to investment in the modernization of public services and infrastructure with a positive impact on

efficiency and the wellbeing of the region beyond the current budget period.

For simplicity, the unit cost of long-term investment y_i is normalized to one for all i, while the supply of z_i entails marginal costs equal to θ_i which may differ across regions. The cost parameters θ_i are independently drawn from a commonly known joint distribution on $\times_{i=1}^{n}[\theta_L, \theta_H]$ with $\theta_H > \theta_L > 1$, with a cumulative distribution function $P(\theta_i|y_i)$, and a density function $p(\theta_i|y_i) > 0$ on $[\theta_L, \theta_H]$ and $\theta_L > p(\theta_L|y_i)$.

In line with Persson and Tabellini (1992) we assume that public investment like the maintenance of infrastructure and the modernization of public services increases local productivity and reduces the expected costs of public good provision z_i in the future, i.e. $\frac{\partial P(\theta_i|y_i)}{\partial y_i} < 0$, $\frac{\partial^2 P(\theta_i|y_i)}{\partial y_i^2} > 0$ (first order stochastic dominance). Further, the monotonous hazard rate condition is fulfilled, i.e. it applies that $\frac{1-P(\theta_i|y_i)}{p(\theta_i|y_i)}$ is non-decreasing in θ_i.

In accordance with chapter 3 each jurisdiction is endowed with one unit of labor, supplied inelastically. The total capital stock in the federation $\bar{K}$ is exogenously given and capital is perfectly mobile across jurisdictions, so that capital in each jurisdiction earns the same net return r. Further we consider the same CES-production technology with output $f(k_i)$, when k_i units of capital and one unit of labor are employed. Moreover we define the local governments' budget constraint as:

$$t_i k_i + s_i = z_i/\theta_i + y_i. \tag{4.1}$$

The LHS of equation (4.1) is the revenue side including tax revenue of a unit tax on capital (which is the only tax local governments can raise) and a federal transfer s_i, while the RHS depicts local government's public expenditures composed of local public good supply z_i and public investment y_i. As investment decisions are enacted in past periods the investment level y_i should be interpreted in terms

of *pro rata temporis*.[3]

Factor markets are taken to be perfectly competitive and the production factors are therefore valued at their marginal value product:

$$f_k(k_i) = r + t_i \qquad \text{and} \tag{4.2}$$

$$f(k_i) - k_i f_k(k_i) = w_i, \tag{4.3}$$

where $r + t_i$ gives the user cost of capital and w_i is the price for the fixed factor in region i. In line with chapter 3 capital is perfectly mobile within the borders of the federation, factor prices adjust to clear markets at the Walrasian equilibrium, so that the following condition hold: $\frac{\partial r}{\partial t_i} = -\frac{k_i'(r+t_i)}{\sum_{j=1}^{n} k_j'(r+t_j)} < 0$, $\frac{\partial k_i}{\partial t_i} = \frac{1}{f_{kk}(k_i)}\left(1 + \frac{\partial r}{\partial t_i}\right) < 0$, and $\frac{\partial k_j}{\partial t_i} = \frac{1}{f_{kk}(k_j)}\frac{\partial r}{\partial t_i} > 0$.

The representative households' total income is composed of wage income and capital income. Representative households spend their whole net income on private good consumption x_i given by

$$x_i = f(k_i) - (r + t_i)k_i + r\bar{k}, \tag{4.4}$$

where we assume that households in each region own an equal share of capital $\frac{\bar{K}}{n} = \bar{k}$.

Local jurisdictions are *regionally benevolent* choosing the capital tax rate as well as the mix of public goods in order to maximize the utility of the representative household. Preferences of a representative household in region i are characterized by the following quasi-linear utility function

$$U_i \equiv U_i(x_i, z_i) = z_i + V_i(x_i). \tag{4.5}$$

In line with chapter 3 we assume that a minimum welfare level in *each jurisdiction* denoted by U^0 is guaranteed by constitutional law. Using local govern-

[3]Investment payments are assessed in proportion to the time range of the investment horizon.

ments' budget constraint (4.1) we can write the insurance constraint as follows:

$$\theta_i \left(k_i t_i + s_i - y_i\right) + V_i(x_i) \geq U^0 \tag{4.6}$$

The central government must choose a transfer payment s_i in order to fulfill the insurance constraint for any region. Again we consider only transfers addressed to jurisdictions, so that inter-personal redistribution programs are ruled out.

4.2.2 The timing of the game

We slightly modify the timing of model in the previous chapter introducing a constitutional level at *stage 0* and a investment level at *stage 1*. Then the timing of the game is as follows:

- At *stage 0* a minimum local welfare level U^0 is guaranteed by constitutional law.
- At *stage 1* local governments decide on long-term investment policies y_i.
- At *stage 2* nature draws cost types θ_i from a distribution of types $P(\theta_i|y_i)$ which crucially depends on public investments y_i.
- At *stage 3* the federal government offers a transfer scheme s_i.
- At *stage 4* local governments pursue tax policies t_i.
- At *stage 5* all parameters of the grant rule are determined and grants are paid to local governments.

4.2.3 The central government's policy

We assume that the central government intends to minimize funds affordable to fulfill the insurance constraint. Accordingly, it offers a system of grants that provides for optimal incentives with respect to local tax policies t_i, so that we

can state the following minimization problem:

$$\min_{t_1,\ldots,t_n,s_1,\ldots,s_n} \sum_{i=1}^{n} E_{\theta_i}\left[s_i(\theta_i)\right]. \tag{4.7}$$

$$\text{s.t. (4.1), (4.4), and (4.6) for all } i.$$

In particular, the central government minimizes the *expected* value of total transfer payments which is consistent with the devolution in the parliament where the federal budget is adopted by future prospects. Besides, by the weak law of large numbers the expected value is converging to the effective payments in case of a federation with many jurisdictions.

4.3 Ex-Ante Transfers

First of all we investigate an ideal federation without any restrictions on the information structure, serving as a benchmark solution. This will help to understand the ex-post redistribution problem in federal states which is going to be analyzed in section four. Accordingly, the central government can act as a Stackelberg leader committing to offer a well-defined transfer scheme, which may depend on the technology type θ_i as well as on local policy measures t_i and y_i.

Most importantly the transfer scheme must meet the insurance constraint given by equation (4.6). In the frame of this model the insurance constraint should be understood as an requirement of the central government to provide equal opportunities for all regions. Therefore, it is sufficient that local governments may attain a minimum welfare level U^0 by enacting an appropriate local policy. This includes that compensatory payments necessary to meet the insurance constraint may be offset against matching grants.

In an ideal federation the central government can offer a transfer scheme $s(\theta_i, t_i, y_i)$ contingent on all relevant parameters θ_i, t_i, and y_i. Employing backward induction we initially analyze local governments' tax policy at *stage 4*

followed by an investigation into local investment policy pursued at *stage 2*. For the sake of clarity we consider all stages of the game although we have already become acquainted with the technique of the tax competition game in the previous chapter. After policy y_i has been chosen and nature has drawn the cost types, local jurisdictions compete for mobile capital, which generates the a tax competition game. We define the best response function of i given its specific technology:

$$BR_i(t_{-i}) = \tilde{t}_i(t_{-i}) = \arg\max_{t_i} z_i + V_i(x_i)$$

$$\text{s.t.} \quad (4.1) \quad \text{and} \quad (4.4),$$

which entails the following first order condition:

$$\theta_i \left(k_i + \tilde{t}_i \frac{\partial k_i}{\partial t_i} + \frac{\partial s_i}{\partial t_i} \right) + V_x(x_i) \left(\frac{\partial r}{\partial t_i} \left(\bar{k} - k_i \right) - k_i \right) = 0 \quad \text{for all } i. \tag{4.8}$$

Regionally benevolent jurisdictions only recognize fiscal effects that impact their own welfare ignoring the positive fiscal effects on neighboring jurisdictions and raise inefficiently low tax rates. In line with the standard tax competition literature the central government must offer a system of matching grants with matching rates $b_i(t_i)$ equal to the marginal external effects of tax competition. As the insurance constraint is binding in the optimum we can express the central government's minimization problem as follows:

$$(t_1^*, ..., t_n^*) = \arg\min \sum_{i=1}^{n} [U^0 - V(x_i) + z_i]$$

$$\text{s.t.} \quad (4.1) \quad \text{and} \quad (4.4), \quad \text{for all } i.$$

The first order condition is given by:

$$\begin{gathered} \theta_i \left(k_i + t_i^* \frac{\partial k_i}{\partial t_i} \right) + V_x(x_i) \left(\frac{\partial r}{\partial t_i} (\bar{k} - k_i) - k_i \right) + \\ \sum_{j \neq i} \left(V_x(x_j) \frac{\partial r}{\partial t_i} (\bar{k} - k_j) + \theta_j t_j^* \frac{\partial k_j}{\partial t_i} \right) = 0, \quad \text{for all } i. \end{gathered} \tag{4.9}$$

The last term on the LHS of (4.9) depicts the marginal external effects of tax competition, which are not taken into account by local policy-makers. Comparing the decentralized solution (4.8) to the first best optimal solution it will become obvious that local public goods are under-provided. Hence, the matching rate $b_i(t_i) = \frac{\partial s_i}{\partial t_i}$ which implements an efficient tax rate t_i^* can be decomposed by adding up equations (4.8) and (4.9) such that:

$$b_i(t_i) = \frac{1}{\theta_i} \sum_{j \neq i} \left(V_x(x_j) \frac{\partial r}{\partial t_i} (\bar{k} - k_j) + \theta_j t_j^* \frac{\partial k_j}{\partial t_i} \right).$$

Next we will consider long term policies on the local level. At *stage 1* local governments choose an investment level y_i that maximizes the *conditional expected value* of local welfare.

$$\tilde{y}_i = \arg\max E_{\theta_i}[V(x_i) + z_i | y_i]. \tag{4.10}$$

$$\text{s.t.} \quad (4.1) \quad \text{and} \quad (4.4).$$

The following first order condition depicts the trade-off in the optimal investment decision:

$$1 = -\int_{\theta_L}^{\theta_H} \left(t_i^* k_i + s_i + \theta_i \frac{\partial s_i}{\partial \theta_i} \right) P_{y_i}(\theta_i | \tilde{y}_i) d\theta_i + \frac{\partial s_i}{\partial y_i}, \quad \text{for all } i, \tag{4.11}$$

where t_i^* is the equilibrium tax rate of jurisdiction i played in the subsequent game at *stage 4* if an externality-correcting grant system is in place. The LHS of equation (4.11) signifies the marginal cost of the long-term policy which is equal to unity. The first term on the RHS denotes the expected marginal benefit of the investment policy. With a well prepared infrastructure expressed by a high amount of y_i the cost of public good supply is expected to be low so that the local government can provide a relatively high amount of public good for one euro. The latter term on the RHS $[\frac{\partial s_i}{\partial y_i}]$ represents the direct marginal impact of policy y_i on the transfer policy.

Assuming that the central government has full commitment devices it may offer an appropriate system of co-funding grants at stage 0 to restate efficiency. Likewise the transfers scheme should implement local investment levels y_i^* which minimize total transfer payments:

$$y_i^* = \arg\max \sum_{i=1}^{n} E_{\theta_i}[U^0 - V(x_i) - z_i]$$

$$\text{s.t.} \quad (4.1) \quad \text{and} \quad (4.4), \quad \text{for all } i.$$

The first order condition reads:

$$1 = -\int_{\theta_L}^{\theta_H} t_i^* k_i P_{y_i}(\theta_i|y_i^*)d\theta_i \quad \text{for all } i, \tag{4.12}$$

By the first order condition (4.12) co-funding $l_i(y_i^*)$ should be equal to the marginal benefit of public investment which is reflected in the expected productivity gain in public good provision, i.e.

$$\frac{\partial s_i}{\partial y_i} = l_i(y_i^*) = -\int_{\theta_L}^{\theta_H} \left(\theta_i \frac{\partial s_i}{\partial \theta_i} + s_i\right) P_{y_i}(\theta_i|y_i^*)d\theta_i.$$

Indeed, if the central government fully insures local governments against technological shocks a typical ex-post transfer problem arises. As disparities among local governments are evened out, any cost benefit in a fortunate event would result in a higher net contribution to the common pool of federal funds whereas cost disadvantages would be compensated at the awkward case. In particular, the marginal impact of the redistributive transfers scheme on investment incentives $[\theta_i \frac{\partial s_i}{\partial \theta_i} + s_i]$ countervails the positive effect of the technological advantage $[t_i k_i]$. Thus, a local welfare maximizing local government cannot derive any advantage from its investment policy:

$$\int_{\theta_L}^{\theta_H} \tilde{t}_i k_i P_{y_i}(\theta_i|y_i)d\theta_i - 1 = \int_{\theta_L}^{\theta_H} \left(s_i + \theta_i \frac{\partial s_i}{\partial \theta_i}\right) P_{y_i}(\theta_i|\tilde{y}_i)d\theta_i$$

Therefore, in the absence of co-funding programs, i.e. $\frac{\partial s_i}{\partial y_i} = 0$, local governments have no incentives to invest any positive level y_i for long-term projects.

For the analysis in section 4.4 it is helpful to highlight that by equation (4.12) the benefit of investment policy moreover depends on the tax revenue raised by a local government at *stage 4*. If local governments expect a small public sector in future periods because of tax competition, they will invest less in long-term policies y_i. In this respect it is important to again note that the federation must compensate for any tax-dumping strategies on the local level the kind of matching rates we have described above. We can therefore state:

Proposition 3 *Higher tax incentives go along with a higher provision of short-term public consumption and higher investment.*

Proof see Appendix

We have shown that local governments underprovide public goods in a twofold way: They under-provide public goods as a well-known result of the tax competition literature and postpone costly long-term investments into the future. Moreover, the decentralized provision of public goods may lead to fiscal disparities if local public good provision entails heterogenous costs. The central government can restore an efficient allocation of public good provision and investment as well as fully equalize disparities by offering a system of ex-ante transfers which make jurisdictions residual claimants of their own policies. However, ex-ante transfers require strong assumptions on commitment devices and on the information structure. In the following section we will discuss to which degree a central government can provide optimal incentives for local policy if the federal policy instruments are restricted and some parameters of the grant rule cannot be predetermined.

4.4 Ex-Post Transfer Schemes

In this section we consider a more realistic framework by assuming an information structure with two-dimensional asymmetric information. Firstly, local

governments may better estimate region specific cost types θ_i than the central government does due to their close relation to on-site problems. Secondly, the central government may not be able to observe the purpose of expenditures, i.e. the mix of locally supplied public goods z_i and investment projects y_i.

Hence, the central government does not have any means to offer a well-defined transfer scheme ex-ante as the investment policy y_i is non-contractible and transfers cannot be paid contingent on local fiscal needs. Therefore, local governments may have some latitude of discretion with respect to local fiscal policies and investment policies. On the one hand, they may recast expenditures for other purposes and thus draw more co-funding grants than appropriate. On the other hand, they may strategically mispresent or hide relevant data in order to substitute higher transfer payments for their own tax revenue.

Although long-term policies carried out at *stage 1* are non-verifiable, the central government can form beliefs $P(\theta_i|y_i)$ on technology types θ_i depending on y_i. As the distribution of cost types is assumed to be common knowledge, it correctly anticipates the pure strategy equilibrium $y_i = \hat{y}$ for all i.

4.4.1 Tax incentives

In order to minimize total transfer payments the central government should offer an transfer scheme contingent on observable tax policy t_i which provides optimal local tax incentives. By the *revelation principle* we can restrict our search for the best federal transfer scheme to direct transfer mechanisms contingent on types θ_i,

$$\hat{\Gamma} = \{N, (t_i(\theta_i, \theta_{-i}))_{i\epsilon N}, (s_i(\theta_i, \theta_{-i}))_{i\epsilon N}, \times_{i=1}^{n}[\theta_L, \theta_H]\},$$

such that truth-telling by all local governments is a Bayes-Nash equilibrium, where the reservation utility U^0 is guaranteed and external effects of tax com-

petition are optimally corrected.[4]

The minimization problem of the central government is as follows:

$$\min_{t_1,\ldots,t_n,s_1,\ldots,s_n} E_\theta[s_i(\theta_i,\theta_{-i})|\theta_i,\hat{y}]$$

$$\text{s.t. } E_{\theta_{-i}}[V(x_i(t_i(\theta_i,\theta_{-i}))) + z_i(t_i(\theta_i,\theta_{-i})), s_i(\theta_i,\theta_{-i}))|\theta_i,\hat{y}] \geq U^0 \tag{4.13}$$

$$\begin{aligned} &E_{\theta_{-i}}[V(x_i(t_i(\theta_i,\theta_{-i}))) + z_i(t_i(\theta_i,\theta_{-i})), s_i(\theta_i,\theta_{-i}))|\theta_i,\hat{y}] \geq \\ &E_{\theta_{-i}}[V(x_i(t_i(\tilde{\theta}_i,\theta_{-i}))) + z_i(t_i(\tilde{\theta}_i,\theta_{-i})), s_i(\tilde{\theta}_i,\theta_{-i}))|\tilde{\theta}_i,\hat{y}] \quad \forall i,\tilde{\theta}_i. \end{aligned} \tag{4.14}$$

Equation (4.13) ensures that every jurisdiction enjoys at least an expected welfare of U^0. Additionally, we have to consider the Bayesian incentive-compatibility constraints (4.14) providing for a truthful revelation of types. Given jurisdiction i's belief with respect to the types of neighboring regions it is never profitable for i to mispresent types which is denoted by $\tilde{\theta}_i \neq \theta_i$. In other words, truth-telling for all i and all θ_i is a Bayesian equilibrium in the direct transfer mechanism. Incentive compatible transfers that guarantee at least U^0 to each jurisdiction are:

$$\begin{aligned} s(\theta_i,\theta_{-i}) = \frac{1}{\theta_i} E_{\theta_{-i}}[U^0 - V(f(k_i) - (r + t_i(\theta_i,\theta_{-i}))k_i + r\bar{k}) - \\ \theta_i\left(k_i t_i(\theta_i,\theta_{-i}) - y_i\right) + \int_{\theta_L}^{\theta_i} k_i t_i(\theta_i,\theta_{-i}) d\theta_i^0 | \theta_i,\hat{y}] \end{aligned} \tag{4.15}$$

To prevent local governments from understating their true types the central government must transfer information rents in addition to the insurance payments necessary to concede U^0. The last term on the RHS of equation (4.15) depicts the information rent. Therefore, in the incomplete information case the central government's redistribution policy calls for lower contribution rates by efficient regions.

Lemma 3 *Local governments can gain a positive information rent which is a decreasing function of types θ_i.*

[4] In Appendix 8.2 we show that the single-crossing property is fulfilled.

This result will have important implications for the degree to which fiscal externalities are corrected through the system of transfers. By using equation (4.15) the federal government's objective function now reads as follows:

$$(\hat{t}_1, ..., \hat{t}_n) = \arg\min \sum_{i=1}^{n} E_{\theta_i}[U^0 - V(x_i(t_i(\theta_i, \theta_{-i})) - \theta_i \left(k_i t_i(\theta_i, \theta_{-i}) - \hat{y}_i\right) + \int_{\theta_L}^{\theta_i} k_i t_i(\theta_i, \theta_{-i}) d\theta_i^0 | \hat{y}]. \tag{4.16}$$

The first order conditions read:

$$\begin{aligned} &\left(\theta_i - \frac{1 - P(\theta_i|\hat{y})}{p(\theta_i|\hat{y})}\right)\left(k_i + \frac{\partial k_i}{\partial t_i}\hat{t}_i\right) + V_x(x_i)\left(\frac{\partial r}{\partial t_i}(\bar{k} - k_i) - k_i\right) \\ &\sum_{j \neq i}\left(V_x(x_j)\frac{\partial r}{\partial t_i}(\bar{k} - k_j) + \left(\theta_j - \frac{1 - P(\theta_j|\hat{y})}{p(\theta_j|\hat{y})}\right)\hat{t}_j \frac{\partial k_j}{\partial t_i}\right) = 0 \quad \text{for all } i. \end{aligned} \tag{4.17}$$

We find that the schedule of tax rates is distorted downward, because the hazard rate $\frac{1-P(\theta_i|\hat{y})}{p(\theta_i|\hat{y})}$ is positive. Consequently, the external effects of tax competition are only partially internalized through the optimal incentive-compatible grant. Thus, in a second best tax policy setting external effects of tax competition are not fully corrected for all types θ_i apart from the highest possible type θ_H.

The trade-off between equity and efficiency has been exposed in detail in chapter 3. As we might recall the rent which local governments may gain by mispresenting data is a decreasing function of the tax rate. This in turn enables the central government to extract some information rents which is welfare enhancing. Since distorted tax incentives involve an inappropriate structure of private and public goods it is less attractive to local governments to mispresent their types. Therefore the central government faces a real trade-off between allocative efficiency and fiscal equity. Overall, the central government offers an incentive scheme to local governments, where at the margin the welfare gain of increased rent extraction and the welfare loss of an incomplete internalization

of fiscal externalities are balanced. We will see in the next subsection how it can be utilized to give a novel resolution to the ex-post -problem, which is at the heart of our study.

4.4.2 Incentives for long-term policy

In this subsection we analyze local governments' incentives to pursue a long-term investment policy in the presence of incentive-compatible grants-in-aid.

At *stage 1* local governments choose a long-term policy in order to maximize expected local welfare. They correctly anticipate that the central government can do no better than by offering an incentive-compatible transfer mechanism at *stage 3*. The optimal Bayesian mechanism derived above is gives the best response the central government has to tackle local governments' opportunistic behavior. From the revelation principle we know that any other transfer scheme would enhance local governments' opportunity to draw additional grants from the common pool. Hence, the results derived above can be interpreted as a conservative estimation of local governments' latitude of discretion. At least local governments can expect an information rent given by equation (4.15).

The local governments' objective function is:

$$\hat{y}_i \arg\max E_{\theta_i}[V(x_i(t_i(\theta_i,\theta_{-i}))) + z_i(t_i(\theta_i,\theta_{-i}),s_i(\theta_i,\theta_{-i})))|y_i] \tag{4.18}$$

$$\text{s.t.} \quad (4.1) \quad \text{and} \quad (4.4),$$

where $s(\theta_i,\theta_{-i})$ denotes the incentive-compatible transfer (4.15) and $t_i(\theta_i,\theta_{-i})$ gives the incentive compatible tax rate. Local governments know that the central government correctly anticipates the policy $\hat{y}$. The first order condition reads:

$$1 = -\int_{\theta_L}^{\theta_H} \hat{t}_i k_i P_{y_i}(\theta_i|\hat{y}_i) d\theta_i. \tag{4.19}$$

Taking into account that the second best optimal tax rate is always distorted downward, i.e. $t_i^* > \hat{t}_i$, we can state the following proposition:

Proposition 4 *In an incomplete information set-up local governments invest an inefficiently low amount in long-term public projects.*

In an environment with incomplete information local governments anticipate that optimal transfer schemes equalize fiscal disparities only partially and correct fiscal externalities only incompletely. Hence, federal transfer mechanisms affect local governments' incentives to pursue a long-term policy in two ways.

Firstly, distorted tax incentives go along with both a lower supply of public goods and less investment in long-term projects, because local governments expect lower tax revenues in the tax competition game to follow. As a consequence, the federation is faced with an inefficiently low public sector as well as a dynamically suboptimal local policy.

Secondly, the ex-post redistribution problem which here takes the form of the *Good Samaritan Problem* is mitigated as grants entail a positive information rent and therefore lack progression. Then local governments are to some extent residual claimant of urban policy decisions. As a positive by-product of incomplete redistribution the *Good Samaritan Problem* is alleviated and local governments have higher incentives for long-term policy. Those regions which modernize public services in due time are likely to dispose of efficient technologies and gain from information rents. Therefore the widespread commitment problem of the central government which insures jurisdictions against local shocks is attenuated in a federation with an incentive-compatible grant scheme. Here, the scope for federal redistribution is limited, so that local governments are encouraged to invest in long term projects on their own initiative.

4.5 Recapitulating the Effects of Ex-Post Transfers

In the frame of a multi-stage game with incomplete information we characterize incentive-compatible transfer mechanisms that provide for fiscal equalization

among local jurisdictions and equally resolve the problem of adverse selection provoking tax dumping. The second best optimal transfer scheme trades-off full equalization of disparities among regions against allocative efficiency. By the informational constraints, the scope for federal redistribution in this model is endogenized and the progressive impact of the transfer scheme is limited. This has important implications for a sustainable policy on the local level. We show to which extent the ex-post-redistribution Problem is mitigated through incentives for local policy in a setting with a second best optimal Bayesian transfer mechanism.

As an extension of the chapter it would be worth to explaining the high divergence of public investment on the local level, see Rodden (2001), who delivers evidence for the German provincial states. Due to Rodden's observation some regions pursue a conservative investment policy, while others tend to bear high risks. In the stylized model of this chapter *a priori* all regions are identical at stage 0, i.e. before the initial investment policy is enacted. Considering a more realistic framework of the model in which local governments *in medias res* may have different starting positions and hence different beliefs with respect to the likelihood of future technological shocks may explain why local governments respond differently to federal ex-post grants.

Chapter 5

Transfers and Informational Externalities

5.1 Interregional Interaction and Expectation

In chapter 3 and 4 we demonstrated that local governments embedded in a federal setting do not act in isolation but interact with neighboring regions. In particular we showed that local governments may compete for mobile resources as well as for transfer from the common pool. A basic message at this juncture is that incentive problem on the local level appears in a different light if we take into account that local governments interact with one another. We learned that tax competition may be beneficial in order to select informational types. Further, it seems to be plausible that local governments have higher incentives to invest in precautionary long-term projects if this opens up for local governments a higher capacity to compete for fiscal commons in the future. In this chapter we point out a third reason for why interregional interaction may affect the local incentive problem in federal states analyzing to which extent policy measures chosen by comparable neighboring regions may serve as a signal for unobservable regional circumstances.

In federations with spatial interrelation, it is plausible that technology types correlate between jurisdictions. We show that local policy performance becomes meaningfully comparable for the central government by implementing a yardstick

competition mechanism. In this case it can reduce local governments' scope to additional grants from the common pool by choosing an untruthful policy. The transfer received by local governments would be a function not only of their own policy measures but also of the performance of neighboring regions. From the view of game theory, an appropriate federal transfer mechanism generates a game in which local governments compete for a bonus payment. Here, the federal government can exploit the fact that self-interested jurisdictions do not internalize the informational externalities on neighboring jurisdictions when they pursue local policy measures. In particular local governments do not take into account that their policy measures serve as a signal for correlated types of neighboring jurisdictions. Therefore, the central government can learn more about local circumstances without offering information rents. In the second step we show that the yardstick competition mechanism may provide positive incentives for local precautionary incentives with implications for the findings in the fourth chapter.

How should a federal transfer system be designed in order to overcome these agency problems if local information types correlate across regions? In this chapter, we address this question and design an optimal Bayesian transfer mechanism offered by the central government that provides optimal incentives for local policy and equalizes disparities across jurisdictions. As an important consideration we highlight the positive effects of yardstick competition between interrelated jurisdictions on the federal redistribution policy. The basic problem to be described is for example in line with the specific environment of local equalizing in the German Länder.

Similar to the latter two chapters, we consider a federal system composed of a central government and several local jurisdictions. Jurisdictions face heterogenous technological shocks and differ in their ability to provide public goods. We

assume that jurisdictions are more familiar with region-specific incidents and, thus, have superior information concerning local provision technologies. Furthermore, in line with the fourth chapter local governments may improve their provision technology through public services innovation, which decreases the expected cost of public good provision, so that the differences across jurisdictions are endogenous. Different to the setting in chapter three we consider a federal state in which local governments may raise undistortive taxes on land rents. Therefore in the frame of this model the interregional competitive behavior is restricted to common pool fishing.

In order to investigate the informational gains of yardstick competition we consider a federation with the same two-dimensional incentive problem in as in chapter: the first dimension is a problem of adverse selection. Transfer payments offered by the central government must be tailored to the current local cost parameters. The cost parameters are, however, overstated by local governments in order to receive higher grants-in-aid. The second dimension has its seeds in the central government's lack of commitment. Local governments may influence the cost of local public good provision by innovation measures in the public sector. They can rely on federal aid, because this is guaranteed by constitutional law. Consequently, they will exert insufficient effort in preventing high provision cost through public service innovation.

Likewise, the central government should offer transfer schemes that provide optimal incentives for local governments' policy. Maximizing the size of the *federal cake* the central government could afford an optimal redistribution policy with a balanced federal budget. With respect to the innovation policy, local governments anticipate that the transfer mechanism entails positive information rents. As we have demonstrated in detail in the previous chapter, more efficient

local technology types can draw higher rents from the common pool. Local innovation policy can therefore be considered as an investment in higher expected information rents.

In federations with spatial interrelation, it is plausible that technology types correlate between jurisdictions. If local policy performance becomes meaningfully comparable for the central government, it can alleviate agency problems by implementing a yardstick competition mechanism. The transfer received by local governments would be a function not only of their own policy measures but also of the performance of neighboring regions. From the perspective of game theory speaking, an appropriate federal transfer mechanism generates a game in which local governments compete for a bonus payment. Here, the federal government can exploit the fact that self-interested jurisdictions do not internalize the informational externalities on neighboring jurisdictions when they pursue local policy measures. In particular local governments do not take into account that their policy measures serve as a signal for correlated types of neighboring jurisdictions. Therefore, the central government can learn more about local circumstances without offering information rents.

Whenever the central government is able to make use of a yardstick competition mechanism, it can extract some information rents. Therefore it can afford to provide more high-powered incentives for public good provision. As a byproduct of yardstick competition local governments innovate public services more intensively. Yardstick competition filters out information about technological circumstances which commonly concern all regions. Hence, in order to gather a higher informational advantage through region-specific parameters local governments innovate public services more intensively. With a more efficient local policy the federal cake augments and the central government can afford a

more generous redistribution policy.

Beside the seminal paper of Persson and Tabellini (1996) the ex-post investment problem is an important theme in industrial organization literature. Laffont and Tirole (1993) have added investment to a principal-agent model, in a similar set-up. The positive effect of yardstick competition on local governments' incentives in a non-commitment set-up to prevent shocks in a principal-agent model was firstly shown by Dalen (1998).

Recently, some papers have focused on analyzing the effects of yardstick competition in federations. Besley and Case (1995) have developed a model of the political economy of tax setting where voters make comparisons between jurisdictions to overcome agency problems. They provide empirical evidence for the yardstick competition effect by using U.S. data. A similar set-up is presented by Bordignon et al. (2003) with Italian data, and by Fiva and Rattso (2005) with Norwegian data. In these papers, yardstick competition serves as an instrument to make the actions of local incumbent politicians more accountable to voters. Two papers consider yardstick competition with federal grants. Boarnet and Glazer (2002) provide empirical evidence that voters regard US federal grants as a signal for the competence of local governments. In contrast Kotsogiannis and Schwager (2006) show that equalizing grants can also reduce political accountability. As grants reduce disparities across regions, the policy of incumbent politicians is less comparable for voters.

As a distinctive feature to the existing literature this chapter deals with appropriate federal transfer schemes that support yardstick competition between local governments. Apparently, the central government can compare local policy in the same way as voters can. Therefore, this chapter should be a contribution to the existing literature, extending the analysis of yardstick competition. Basi-

cally, the process of yardstick competition which we are going to analyze in this chapter is in the same spirit as the one demonstrated in the existing literature: local performance is compared in order to update beliefs of local types. The underlying incentive scheme in Besley and Case (1995), Bordignon et al. (2003), Fiva and Rattso (2005) are a voting process in an political economy setting while we consider redistributive federal grants. The following questions are affiliates with the problem under examination: What are the characteristics of transfers that induce local government to compete for a yardstick? To which extent can the central government enlarge its federal redistribution program by implementing a yardstick competition mechanism?

The chapter outline is as follows. The second section sets out the basic model and defines the socially optimal local policy as a reference for later results. As a further benchmark we propose an incentive-compatible transfer that tackles adverse selection in section 5.3. Then, we revise this transfer scheme by implementing a yardstick competition mechanism which exploits correlation between informational types in section 5.4. Yardstick competition emerges as a valuable instrument to increase the scope for federal redistribution. Section 5.5 concludes.

5.2 The Basic Model

Consider a federation consisting of a central government and n jurisdictions with equal land endowment, indexed by $i = 1, ..., n$. In the federal state mobile firms produce a private numeraire good with the same constant return-to-scale production technology $F \equiv F(l)$, where l is the amount of land used by a firm. In equilibrium, the market clearing price for land is $\rho = F_l$ and there is an equal number of firms in each jurisdiction, which we normalize to one. The indwellers of i owning the land endowment in i are characterized by their quasi-linear utility

functions $U_i \equiv U(x_i, z_i) = x_i + V(z_i) + h_i$ (with $\frac{\partial V}{\partial z_i} > 0$ and $\frac{\partial^2 V}{\partial z_i^2} < 0$), where x_i is the consumption level of a private numéraire good and z_i, h_i denote the supply of two local public goods. In the provision of z_i and h_i, there are no spill-over effects on neighboring regions j.

Local jurisdictions raise a non-distortive tax on land rents T_i to finance local policy measures: They provide the local public good z_i and further undertake innovations in their local public services y_i. With a balanced budget it applies that $T_i + \tau_i = \frac{z_i}{\beta_i} + y_i + h_i$, where τ_i is a federal transfer received by i. The first term on the right side denotes expenditures for supply of z_i. Here, $\beta_i \epsilon [1, 2]$ is a region-specific cost parameter privately known by i. From an outside view, the probability that the cost parameter for public good provision will be less or equal to β_i given that the local government has undertaken innovation policy y_i, is defined $Prob(\beta \leq \beta_i | y_i) = P(\beta_i | y_i)$. The density function is defined by $p(\beta_i | y_i)$. We assume that investment in public service innovation y_i reduces the danger that the provision of public goods entails high cost, so that $\frac{\partial P(\beta_i|y_i)}{\partial y_i} < 0$, $\frac{\partial^2 P(\beta_i|y_i)}{\partial y_i^2} > 0$ holds. Besides, the probability distribution fulfills the monotone hazard rate property $\frac{\partial}{\partial \beta_i}\left(\frac{1-P(\beta_i|y_i)}{p(\beta_i|y_i)}\right) \leq 0$. Moreover, we assume that the central government cannot distinguish between expenditures for innovation measures y_i and for public good consumption h_i, so that local innovation policies are non-verifiable for the central government. The private budget constraint is defined by $x_i = \rho l - T_i$ or equivalent $x_i = F(l) - \frac{z_i}{\beta_i} - y_i - h_i + \tau_i$ as we consider a constant return-to-scale technology. Local welfare maximizing local governments decide on expenditures for public good provision and public service innovation, which are financed via a land rent tax.

Welfare differs among jurisdictions as the provision of public goods entails heterogenous cost. According to constitutional law of the federal state a min-

imum welfare level is guaranteed in each jurisdiction denoted by U^0. In this section we consider a central government policy which slightly differs from that exposed in section 3 and 4. Yet the central government should concede the *highest affordable* welfare guarantee in each jurisdiction by offering grants-in-aid τ_i, not being necessarily positive, to the local governments to meet:

$$F(l) - \frac{z_i}{\beta_i} - y_i + V(z_i) + \tau_i(\beta_i) \geq U^0. \tag{5.1}$$

The welfare guarantee issued by the central government is affordable if *expected* total transfer payments meet the federal budget constraint, which is normalized to zero:

$$nE_{\beta_i}[\tau_i(\beta_i)] \leq 0. \tag{5.2}$$

Evidently, it deals with the dual problem of the central government optimization investigated in chapter 3 and 4. In this model, we assume that the budget constraint must only be met by an expected value. It is common practice that the government budget will be adopted by future prospects. Further, if this model is a short-cut of a multi-period game, the central government can intertemporally balance its budget, provided that equation (5.2) holds.

The timing of the game is as follows:

- At t_0 local jurisdictions choose their innovation policy y_i.
- At t_1 nature draws β_i, which is learned by local jurisdictions.
- At t_2 the central government offers a transfer scheme.
- At t_3 local jurisdictions choose tax rates and determine (z_i, h_i).

The innovation measures enacted at t_0 can be interpreted as long term investments to improve public services. Local governments know the conditional distribution of types and choose an innovation measure y_i. Further they are aware

of the central government's policy objective to maximize U^0. At t_1 local governments learn types β_i, drawn by nature. The central government offers a transfer mechanism at t_2 to guarantee a maximal affordable U^0 and to give an optimal incentive for public good provision. Local governments provide public goods (z_i, h_i) at t_3. The welfare guarantee is a basic principle in federations, but parameters in federal redistribution systems can easily be changed by the central government in every period. In Germany for example an equal living standard is irreversibly guaranteed by the constitution of the Länder and the German Grundgesetz. However, the Länder can change parameters of local redistribution programs [1]. We assume that the central government cannot commit to any bonus payments in order to give higher incentives for innovation at t_0. The central government can solely provide incentives for an optimal local policy by an adequate transfer scheme. Equation (5.1) and (5.2) together yields:

$$E_{\beta_i}[F(l) - \frac{z_i}{\beta_i} - y_i + V(z_i)] \geq U^0 \tag{5.3}$$

By equation (5.3), the guaranteed welfare U^0 cannot exceed the expected local *net* welfare. In line with standard results in the literature, the highest affordable welfare guarantee U^0 requires a local provision and innovation policy that maximizes the size of the *cake* $(\mathbf{z}^*, \mathbf{y}^*)$.

The first-best optimal local public good supply is defined by

$$z_i^*(\beta_i) \arg\max F(l) - y_i^* + \int_1^2 V(z_i(\beta_i)) - \frac{z_i(\beta_i)}{\beta_i} p(\beta_i|y_i^*) d\beta_i,$$

given that jurisdictions have chosen y_i^* in t_1. The first order condition fulfills the Samuelson condition for local public good provision , i.e.

$$MRS_{xz}(z_i^*(\beta_i)) = V_z(z_i^*(\beta_i)) = \frac{1}{\beta_i} = MRT_{xz}(\beta_i) \quad \text{for all } i,$$

[1] A legal basis is given by Sächsischer Landtag (2003): *Gesetz zur Änderung von Gesetzen des kommunalen Finanzausgleichs.* See also Watt and Hobson (2000) and Fehr (2001).

so that the marginal valuation of the public good in terms of the private good is equal to the marginal rate of transformation.[2]

The first-best optimal innovation policy y^* is defined by

$$y_i^* \epsilon \arg\max F(l) - y_i + \int_1^2 V(z_i^*(\beta_i)) - \frac{z_i^*(\beta_i)}{\beta_i} p(\beta_i|y_i) d\beta_i,^3$$

given that jurisdictions will chose z^* in t_0. By the first order condition the expected positive marginal effects of the innovation policy on the size of the cake are equal to the marginal cost, which is given by

$$-\int_1^2 \frac{z_i^*(\beta_i)}{\beta_i^2} P_{y_i}(\beta_i|y_i^*) d\beta = 1. \quad \text{for all } i.$$

5.3 Equalizing Grants in a Non-Correlated World

Let us turn to the case where local technology parameters are private information of the jurisdictions and expenditure on h_i and y_i is non-verifiable[4]. In this case the central government faces two important incentive problems on the local level.

A transfer scheme that equalizes welfare on the local level has to be tailored to the current cost parameter. High cost types have more fiscal needs and should therefore receive higher grants-in aid. However, local welfare maximizing jurisdictions overstate their true types in order to receive higher grants-in-aid. Then they spend the excess on the non-verifiable public good h_i.

Public service innovation reduces the expected cost of local public good provision. However, if jurisdictions rely at t_0 on the federal welfare guarantee incentives for costly innovation then measures diminish.

In order to design the optimal transfer scheme, the federal level needs to take into account the informational constraints. By the revelation principle, the

[2]With a marginal rate of transformation which is a decreasing function in β_i, the so-called sorting condition is fulfilled.

[3]Integration by parts yields $F(l) - y_i + \int_1^2 V(z_i^*) p(\beta_i|y_i) d\beta_i - \frac{z_i^*}{\beta_i} P(\beta_i|y)|_1^2 - \int_1^2 \frac{z_i}{\beta_i^2} P(\beta_i|y_i) d\beta_i$.

[4]Rodden (2001) has pointed out that the central government may find it hard to ascertain the purpose of expenditures as it "is not difficult to recast a variety of expenditure as investment outlays".

central government can restrict its search for the optimal transfer mechanism to a direct revelation mechanism. In particular we consider a Bayesian incentive compatible transfer scheme that implements an optimal local provision policy in dominant strategies, which is formally expressed by

$$\Gamma = \{N, (z_i(\beta_i, \beta_{-i}))_{i\epsilon N}, (\tau_i(\beta_i, \beta_{-i}))_{i\epsilon N}\}.$$

We see two important arguments to consider dominant strategy implementation. Firstly, the central government can afford the same U^0 guarantee with a dominant strategy implementation as a Bayesian strategy implementation in the contract specific environment of this model. This proof is provided in Appendix 9.7. Secondly, the extended transfer mechanism including yardstick competition in chapter 4 can be analyzed more straightforwardly with a dominant strategy implementation.

The central government chooses a transfer scheme that includes a local policy in order to maximize the welfare guarantee U^0:

$$\max_{\{z_i(\cdot),\tau_i(\cdot)\}} \quad U^0$$

$$\text{s.t.} \quad F(l) + \tau_i(\beta_i, \beta_{-i}) - \frac{z_i(\beta_i, \beta_{-i})}{\beta_i} - \hat{y} + V(z_i(\beta)) \geq U^0 \tag{5.4}$$

$$E_{\beta_i|\hat{y}}[\tau_i(\beta)] \leq 0 \tag{5.5}$$

$$V(z_i(\beta)) - \frac{z_i(\beta)}{\beta_i} + \tau_i(\beta) \geq V(z_i(\tilde{\beta})) - \frac{z_i(\tilde{\beta})}{\beta_i} + \tau_i(\tilde{\beta}) \qquad \text{for all } i. \tag{5.6}$$

By equation (5.4), a minimum welfare level U^0 is guaranteed in each jurisdiction i. Equation (5.5) gives the domain of affordable redistribution policies. The expected total transfer payments do not exceed the federal budget. As the expected effectiveness of public service innovation is common knowledge the central government correctly anticipates the pure strategy equilibrium $y_i = \hat{y}$ for all i. This gives rise to the cumulated distribution function $P(\beta_i|\hat{y})$ and

innovation cost $\hat{y}$. The optimal local governments' innovation strategies are going to be analyzed in detail in the next subsection. Further, the incentive-compatibility constraint (5.6) ensures that mispresenting types, denoted by $\tilde{\beta}_i$ different to β_i, is never profitable and dominated by truth-telling. Before we solve the central government's maximization problem we characterize a transfer scheme which is truthful and guarantees U^0. This reduces the problem to just one unconstrained maximization of the following objective function:

Proposition 5 *Incentive compatible transfers that guarantee at least U^0 to each jurisdiction are:*

$$\tau_i(\beta) = U^0 - F(l) + \hat{y} + \frac{z_i(\beta)}{\beta_i} - V(z_i(\beta)) + \int_1^{\beta_i} \frac{z_i(b)}{b_i^2} db_i. \tag{5.7}$$

Proof *see Appendix*

To prevent local governments from understating their true types, the central government must transfer information rents additional to the compensatory transfer payments necessary to concede U^0. The first five terms on the right-hand side of equation (5.7) depict the compensatory payments and the last term represents the information rent. The scope for federal redistribution is smaller than in the first-best optimal case as in the incomplete information case, the central government must offer positive information rents. To make this clear, we add up the budget constraint (5.5) and the incentive compatibility constraint (5.7), which yields the scope for federal redistribution in the incomplete information case:

$$E_{\beta_i|\hat{y}} \left[F(l) - \frac{z_i(\beta)}{\beta_i} - \hat{y}_i + V(z_i(\beta)) - \int_1^{\beta_i} \frac{z_i(b)}{b_i^2} db_i \right] \geq U^0. \tag{5.8}$$

The central government chooses a schedule of public good provision $z_i(\beta)$ that maximizes the affordable welfare guarantee U^0 or in other words maximizes the scope for federal redistribution. Integration by parts yields the following maximization problem:

$$\max_{z_i} \int_1^2 \left(V(z_i(\beta)) - z_i(\beta) \left(\frac{1}{\beta_i} + \frac{1 - P(\beta_i|\hat{y})}{p(\beta_i|\hat{y})} \frac{1}{\beta_i^2} \right) \right) p(\beta_i|\hat{y}) d\beta_i.$$

The first order condition is:

$$MRS_{xz}(\hat{z}_i(\beta)) = MRT_{xz}(\beta_i) + \frac{1 - P(\beta_i|\hat{y})}{p(\beta_i|\hat{y})} \frac{1}{\beta_i^2} \quad \text{for all } i. \tag{5.9}$$

Note that the second term on the right-hand side in equation (5.9) is positive for all $\beta_i < 2$ and for $\beta_i = 2$. Consequently, we can state:

Proposition 6 *The second best optimal federal grant-in-aid in an incomplete information set-up entails a schedule of public good supply that is distorted downward for all* $\beta_i < 2$.

The central government faces a trade-off between maximizing the size of the cake and minimizing information rents. At the optimum which is expressed by the first order condition (5.9), the expected marginal effects on the information rents must be equal to the marginal effects on size of the cake. Here, the allocative objective to maximize the size of the cake interferes with the redistributive objective, as a high schedule of public good supply entails high informational cost.

5.3.1 The innovation policy

In line with Persson and Tabellini (1992) and the model of chapter 4 we assume that local governments can innovate public services at t_0, which reduces the expected cost for public good provision. Do local governments, which are insured by a federal welfare guarantee, innovate public services efficiently? To answer this question we investigate the local innovation policy in the remainder of this section: In equilibrium jurisdictions correctly anticipate an incentive-compatible transfer mechanism offered by the central government at t_2, as given in equation (5.7). Jurisdictions, especially expect a positive information rent offered by the central government. This rent increases with the technology parameter β_i. Public service innovation reduces expected provision cost and, at the same time, increases expected information rents. Local governments choose innovation

policies to maximize the expected local welfare:

$$E_{\beta_i|y_i}\left[U^0 + \int_1^{\beta_i} \frac{\hat{z}_i(b)}{b_i^2} db_i\right] - y_i.$$

Integration by parts yields the following maximization problem:

$$\hat{y}_i = \arg\max - \int_1^2 \frac{\hat{z}_i(\beta)}{\beta_i^2} P(\beta_i|y_i) d\beta_i - y_i.$$

The first order condition is:

$$-\int_1^2 \frac{\hat{z}_i(\beta_i)}{\beta_i^2} P_y(\beta_i|\hat{y}_i) d\beta_i = 1.$$

At the optimum, jurisdictions face a trade-off between the positive marginal effects on expected information rents and the marginal cost of public service innovation. All jurisdictions rely on U^0 and pursue an innovation policy $y_i = \hat{y}$, in order to increase expected information rents. However, they do not internalize the positive effects on the whole size of the cake. Furthermore, local governments anticipate that the central government distorts towards a lower public good supply in the second best optimal transfer mechanism to appropriate information rents.[5] Therefore, the individual rational innovation policy on the local level is lower than the first best optimal policy y_i^*, which we have defined in section 2.

Proposition 7 *Jurisdictions invest less in public service innovation if they anticipate that the central government provides less high-powered incentives for local public good supply.*

Proof *see Appendix*

Local decision-makers just enact innovation measures, if this positively affects the prospect of higher local welfare. The positive information rents for local governments that add up on compensating payments forbid the central government to offer complete redistribution to jurisdictions. As the central government is

[5]Remember that by assumption the central government cannot commit to a higher schedule of public good supply which would entail higher expected information rents and higher innovation incentives.

unable to commit itself to bonus payments for local jurisdictions, it is just the lack of insurance that gives incentives to local governments for innovation.

5.4 Equalizing Grants with Yardstick Competition

In accordance with chapter 3 and 4, we have analyzed in the previous section a set-up in which costs to provide public goods are specific parameters of jurisdictions independent of their neighbors. However, in a federation with spatial interaction, it is plausible that some circumstances affect the entirety of jurisdictions' technology types. The local level in a federal state may face a general *bad* or *good* condition, so that there is a tendency towards low or high technology types. We show that the central government can exploit the correlation between informational types to bridge its informational gap at no cost. Because of the correlation between types, the public good supply chosen by a local government i serves as a signal for neighbors' local types. Therefore, by its policy choice, a local welfare maximizing jurisdiction inflicts informational externalities onto its neighbors. The externalities consist of a reduction in neighbors' rents as the central government can update its beliefs.

To investigate the central government's redistribution policy with correlated types, we redefine the local technology parameter for the remainder of this chapter. Two factors affect the cost of providing local public goods: a region-specific factor and a common factor. The first factor is specific to a particular jurisdiction and the latter summarizes all circumstances having an impact on the whole federation. We define the technology parameter by $\beta_i = \xi + \epsilon_i$, where ξ signifies the common regional shock and ϵ_i signifies the region-specific shock in jurisdictions i. ξ may take one value of a set $\{1, \frac{3}{2}\}$ with probability $\{v, 1-v\}$. ϵ_i is drawn from a continuum of types on $[0, \frac{1}{2}]$ with a cumulative distribution function $G(\epsilon_i)$ and a density function $g(\epsilon_i) > 0$ on $[0, \frac{1}{2}]$. In analogy to section

3, public sector innovation reduces the expected cost of public good provision so that $G_y < 0$ and $G_{yy} > 0$ (first order stochastic dominance) hold. Hence, the cumulative distribution function is:

$$P(\beta_i|y_i) = \begin{cases} vG(\beta_i - 1|y_i)) & \beta_i \leq \frac{3}{2} \\ v + (1-v)G(\beta_i - \frac{3}{2}|y_i) & \beta_i > \frac{3}{2} \end{cases} \tag{5.10}$$

The central government knows that the federation is either in a good or bad condition. In the first case, local types take a value on $[1, \frac{3}{2}]$ and in the latter case on $(\frac{3}{2}, 2]$. To exploit the jurisdictions' informational externalities caused by the correlation between types, the central government can offer a yardstick competition mechanism:

In t_2, the central government offers two incentive-compatible transfer schemes Γ_k. The version k of the transfer mechanism for jurisdiction i solely depends on the neighbors' messages β_{-i}. Hence, by its message jurisdiction i cannot influence the version of the transfer mechanism in force:

$$\Gamma_k = \{N, (z_{ki}(\beta_i, \beta_{-i}))_{i \epsilon N}, (\tau_{ki}(\beta_i, \beta_{-i}))_{i \epsilon N}\} \quad \text{with } k = 1, 2.$$

$$\text{Jurisdiction i plays} \begin{cases} \Gamma_2 & \text{if} \quad \sup\{\beta_{-i}\} \epsilon (\frac{2}{3}, 2] \\ \Gamma_1 & \text{otherwise.} \end{cases} \tag{5.11}$$

This mechanism disposes Γ_2 to jurisdiction i, if one neighbor reports a type higher than $\frac{3}{2}$, otherwise Γ_1. It generates a game under complete information (the local government commonly know the factor ξ) allowing the central government to learn the factor ξ without offering information rents.

The type k of the game Γ_k, played by jurisdiction i solely depends on the vector of neighbors' messages β_{-i}. The local government i thus cannot influence k. By definition both transfer mechanisms are incentive-compatible, i.e. jurisdiction i cannot be better off by misrepresenting its type. It reveals the true type, irrespective of the game version k. Further, the truthful revelation of the

technology parameter by jurisdiction i has an impact on the game version of its neighbors j. In the Nash equilibrium all jurisdictions truthfully report their types and play the same game version k, contingent on the common factor ξ. Then the transfer scheme depicts a function with a jump at $\beta_i = \frac{1}{2}$.

By means of the yardstick competition mechanism the central government can filter out some private information at no cost. Thus, the range of possible local informational types is halved from $[1, 2]$ to $[1, \frac{3}{2}]$ or $(\frac{3}{2}, 2]$. Thereby the central government can tailor transfer schemes more accurately to the current local situation. With a smaller range of possible types local governments have a limited scope to mispresent types and a smaller information rent has to be bestowed in order to achieve truth-telling. The central government's maximization problem is now a two-part problem: determining the schedule of public good supply for the *good* and *bad* common factor, respectively:

$$\max_z \int_1^{\frac{3}{2}} \left(V(z_i(\beta)) - z_i(\beta) \left(\frac{1}{\beta_i} - \frac{1 - G(\beta_i - 1|\hat{\hat{y}})}{g(\beta_i - 1|\hat{\hat{y}})} \frac{1}{\beta_i^2} \right) \right) g(\beta_i - 1|\hat{\hat{y}}) d\beta_i$$

$$\max_z \int_{\frac{3}{2}}^2 \left(V(z_i(\beta)) - z_i(\beta) \left(\frac{1}{\beta_i} - \frac{1 - G(\beta_i - \frac{3}{2}|\hat{\hat{y}})}{g(\beta_i - \frac{3}{2}|\hat{\hat{y}})} \frac{1}{\beta_i^2} \right) \right) g(\beta_i - \frac{3}{2}|\hat{y}) d\beta_i$$

The first order conditions are:

$$MRS_{xz}(\hat{\hat{z}}_i(\beta)) = MRT_{xz}(\beta_i) + \frac{1 - G(\beta_i - 1|\hat{\hat{y}})}{g(\beta_i - 1|\hat{\hat{y}})} \frac{1}{\beta_i^2} \quad \text{for } \xi = 1. \tag{5.12}$$

$$MRS_{xz}(\hat{z}_i(\beta)) = MRT_{xz}(\beta_i) + \frac{1 - G(\beta_i - \frac{3}{2}|\hat{\hat{y}})}{g(\beta_i - \frac{3}{2}|\hat{\hat{y}})} \frac{1}{\beta_i^2} \quad \text{for } \xi = \frac{3}{2}. \tag{5.13}$$

The two first order conditions (5.12) and (5.13) express the trade-off between extracting information rents and efficiently providing public goods. A distortion of public good supply of a jurisdiction i with type β_i affects the information rents of those local governments with a type on the interval $[\beta_i, \frac{3}{2}]$, if $\xi = 1$ and on the interval $[\beta_i, 2]$, if $\xi = \frac{3}{2}$. In the federation with $\xi = 1$, the distortion of the schedule of public good provision affects the rents of a smaller set of jurisdictions

compared to the transfer mechanism in section 3. As the rent extraction effect of distorting public good supply is smaller, the central government chooses a transfer scheme which entails higher public good provision. This fact is established by the the following proposition.

Proposition 8 *For given beliefs about the local innovation policy the central government offers a transfer scheme with:*

- *the same schedule of public good supply as in the case with independent local types, if* $\xi = \frac{3}{2}$.
- *a less distorted schedule of public good supply, if* $\xi = 1$.

Proof *see Appendix*

We have shown in the previous section, that jurisdictions innovate public services in order to maximize the expected information rents. Jurisdictions anticipate that a rational federal government in the regime with yardstick competition will offer transfer mechanism with a different schedule of local public good supply. What is the impact of a yardstick competition mechanism on jurisdictions' innovation incentives? If the central government filters out the common components and updates its beliefs the trade-off between rent extraction and efficiency shifts towards a more high-powered schedule of local public good supply. This means that the *marginal* effect on information rents, as captured by the term $\int_1^2 \frac{z_i(\beta)}{\beta_i^2} P(\beta_i|y_i)d\beta_i$ is positive, and as a consequence, y_i increases.

Proposition 9 *In federations with yardstick competition, jurisdictions have higher incentives to innovate local public services.*

Proof *see Appendix*

Most importantly the size of the cake depends on local governments' policies pursued in order to supply local public goods and innovate public services. Furthermore, information rents limit the scope for federal redistribution policy. In the federation with yardstick competition the federal government can

filter out some information about the common component. *A priori*, the federal government expects to pay lower information rents to local governments. Moreover, with proposition 8 and 9, the local governments provide public goods more efficiently and take innovation measures more efficiently. The expected local performance will be therefore higher in a regime with yardstick competition. To conclude the analysis of the achievement of yardstick competition mechanism for federal redistribution we can state:

Proposition 10 *In federations with yardstick competition the scope for federal redistribution is higher: a higher welfare guarantee can be afforded.*

5.5 Yardsticks and Transfers

In this chapter, we have highlighted the advantages of yardstick competition for federal redistribution policy. A yardstick competition mechanism that makes local performance meaningfully comparable, disables local governments from shifting the burden of local policy onto the federation as a whole. The optimal transfer mechanism *with* yardstick competition entails lower information rents and provides higher incentives for local public good provision and higher incentives for local public service innovation. We have suggested that for the analysis of federal equalizing grants it might be reasonable to keep track of a possible correlation between local information types.

The definitions of the common and region-specific factors implies that we consider a moderate correlation between types. If the weight of the region-specific factor is too big, the central government cannot take considerable advantage of yardstick competition. Conversely, a big weight on the common factor is advantageous to filter out some information through yardstick competition. Indeed, this would be the case of a federation with homogenous jurisdictions that does not call for federal redistribution.

We have restricted ourselves to direct transfer mechanisms with yardstick competition, i.e. a message game in which jurisdictions directly announce their technological types. By the revelation principle we can convert each direct mechanism into an indirect transfer mechanism with a matching grant contingent on local public good supply. Similar to the transfer scheme developed in chapter 3 we may develop a class of indirect transfer mechanisms to compare this incentive-compatible transfer scheme with existing transfer schemes, e.g. Canadian, German or Swiss grants. Thus, this general yardstick competition mechanism can be a guideline for further analysis.

Recently, in many federal states a better comparability of local public policy measure is coming up to discussion. For example the Gemeindeprüfungsanstalt-GPA, an agency for municipal audit of the Land North Rhine-Westphalia has introduced an index to evaluate public service innovation. The best practice program can be accompanied by a transfer scheme which makes correlated municipal policy more accountable.

Chapter 6

Tax Base Equalizing and Incentives

6.1 Competition for Tax Base Equalizing Grants

In the analysis of the foregoing chapters it has become obvious that interregional competition with specific variables may be based on different processes and mechanisms. We have demonstrated that competition between local governments can be based different variables, e.g. on mobility of individuals, goods, factors or firms and on transfer from a federal common pool. Moreover they may engage in competition for the same background by choosing different variables. In chapter 3 we have shown that local governments can reduce tax rates in order to attract mobile resources from other regions or to draw additional grants from the common pool. Further in the dynamic context of chapter 4 local governments may postpone long-term investment projects into the future anticipating that they are eligible for financial assistance in the case of high consequential cost.

Hereafter we would like to investigate the typology of the underlying mechanism and the optimal design of transfer schemes in a different environment. In particular we are going to consider tax base equalizing grants, which are an integral part of the federal transfer system in Germany and Canada. In Germany on the municipal level and in Canada on the level of provinces regions with a

below-average tax base are net recipients and those with an above-average one are net contributors to the federal redistribution system.

As a distinctive feature Bucovetsky and Smart (2005) and Köthenbürger (2002) point out that tax base equalizing grants correct for the external effect of fiscal competition. If jurisdictions attract mobile tax bases, a tax cut will lead to an inflow of tax base from neighboring regions, however it equally reduces the governments' entitlement to benefit from tax base equalizing. Hence, the tax back effects that go along with tax sharing restores efficiency: the incentive effects of competition for transfers may neutralize the external effects of tax competition for mobile tax bases. In terms of G. Becker' s *Rotten Kid Theorem* we can argue that local governments would correctly anticipate that the only way to increase the regional budget after central government's tax sharing programs are enacted is to broaden the overall federal tax base.

It is well understood that Rotten Kids may go wrong if local governments privately know some relevant information, so that transfers cannot be precisely tailored to the local situation. Likewise, tax base equalizing may undermine local tax incentives and is a source of inefficient local tax policy itself. In this chapter we consider a setting in which local governments themselves are responsible for administrating and enforcing taxes so that they have some power of discretion to interpret tax law, to audit taxes, and to accord indirect subvention to firms. Decentralized tax enforcement is a typical feature in many federal states. In particular this can be justified by the informational advantage of local tax authorities which can detect tax evasion more easily because of their proximity to the tax payer. Typically, the central government cannot observe and verify enforcement policy enacted by local authorities. In this case local governments local governments have a second policy variable in their hands choosing lax en-

forcement activities in order to reduce the tax burden of firms in the region. A loss of tax revenue, however, is compensated by higher grants-in-aid offered by the central government.

The central government cannot aggregate the factor demands in different local industries to estimate the tax base. The tax base (e.g. the employment of capital in the region) can only be estimated if the tax revenue, as well as the effective tax rate, are known. The reason for an asymmetric information structure in the game is complexity. Bordignon et al. (2001) point out that these informational constraints are likely to arise in many real world situations in federal states. Further, local governments typically have better information about true market values of real estate and other investments in the region. Local governments can better evaluate the real efficiency of regional production facilities because of their proximity to on-site problems. Moreover, the central government cannot observe the relatively complex administrative procedures of tax enforcement.

With decentralized tax authorities, local governments have an additional tax instrument in their hands to engage in tax dumping. Hence, what we expect is that the efficiency consequences of tax base equalizing may differ from recent literature by Bucovetsky and Smart (2006) and Köthenbürger (2002), which displays a positive tax raising effect of tax base equalizing. The general problem of local governments cutting effective taxes via lower enforcement activities is widely discussed in the literature. Specifically, Cremer and Gahvari (2000), and Stöwhase and Traxler (2005) point out that local governments cut effective taxes via lower tax auditing. Lenk et al. (1998) show that some provincial states in Germany exert too little effort for tax audits and Wurzel (1999) points out that the average time between company tax audits in some German provincial states

lasts up to several decades. Lax enforcement activities caused by decentralized tax enforcement is also pointed out by OECD (2006) in its survey of Germany.

In this paper we broaden the tax competition game as displayed by Bucovetsky and Smart (2006) and introduce a second local tax instrument, namely enforcement activities. In order to reduce fiscal disparities, the central government offers tax base equalizing grants. In the full information case, serving as a reference solution for further analysis, all relevant parameters are common knowledge so that the federal government can observe the effective tax rate as well as the tax base. The tax back effect provides optimal incentives for tax policy as well as enforcement policy in agreement with Bucovetsky and Smart (2006). In a federation with decentralized tax authorities and an appropriate system of tax base equalizing grants, taxes are optimally enforced by the local level. In a second step, we consider an incomplete information case. In contrast to Bucovetsky and Smart (2006), the central government cannot observe enforcement activities as well as the size of the tax base. Here, the central government faces an adverse selection problem as local governments mispresent local fiscal power in order to justify a low tax revenue, i.e. they choose a lax enforcement policy in order to cut effective taxes and, hence, reduce the tax burden of local firms.

How should a system of tax base equalizing grants be designed in order to overcome the problem of adverse selection? Here we design an incentive-compatible transfer mechanism that equalizes regional tax bases and equally overcomes the adverse selection problem. In accordance with the foregoing chapters of this study transfer payments entail a positive information rent, so that it is not advantageous for local governments to deviate from the efficient enforcement policy. The second best optimal transfer scheme trades off efficient

incentives for local enforcement policy and full equalization of fiscal externalities. This transfer may be optimal to distort incentives for enforcement activities in the following two ways: the system of grants provides high incentives for regions with small tax bases and vice-versa low tax incentives for regions with a big tax base.

In a second step we are going to derive an in direct transfer rule contingent on observable tax revenues. The central government intends to implement the second best optimal solution with the aforementioned two-way distortion. Likewise, it anticipates the local government try to attract both mobile tax bases from neighboring regions and additional grants from the common pool. Further it rationalizes that local government may engage in tax competition by choosing related strategic variables like enforcement activities.

With respect to the applied fiscal policy this study shows that a rather complex incentive-compatible transfer rule can be implemented by a simple tax base equalizing grants with different contributions rates for different region-specific types. Further, in theoretic terms we try to give new insights how interregional competition may take place depicting a mechanism with different backgrounds and different strategic variables. In the model we consider local enforcement activities as a second variable with which local governments can circumvent the incentive scheme. In broader sense we can also include into the set of local governments' strategic policy instruments subventions for firms and the provision of specific inputs.

Like in our paper, Lockwood (1999) investigates a transfer scheme that simultaneously protects against shocks of provision costs, local income, and valuation of the public goods and corrects for externalities. The externalities considered in this paper result from spillover effects of public goods provision across local gov-

ernments within the federation. Lockwood finds that the form of the optimizing grant differs from the standard Pigouvian subsidy in the full information case and points out a trade-off between rent-extraction and efficiency for different shocks. In line with Lookwood (1999), we deliver another example of a two-way distortion of tax incentives by a federal redistribution system. Technically, speaking it is the same effect which drive the result to a two-way distortion. it is hoped that we throw light on the background of the underlying competitive mechanism. With respect to empirical studies, two papers confirm the hypothesis that local governments try to substitute tax revenue for higher grants-in-aid. Baretti et al. (2002) performed empirical tests confirming this hypothesis for higher-level federal grants.

6.2 Model and Problem

6.2.1 Basic model

We consider a federation composed of a federal government and a large number of local jurisdictions, indexed by $i = \{1, 2, ..., n\}$. Local public good supply is financed by a unit tax on capital employment with a uniform tax rate τ in all regions. We assume that the tax is collected and administered by local governments through local tax authorities who may enact tax audits and related enforcement activities in order to limit tax evasion. Typically relatively high tax revenues T_i may be achieved if local tax authorities exert a high effort to enforce taxes. For simplicity we depict the positive impact of local enforcement activities ρ_i on the tax revenue by the following linear relationship:

$$\tau \rho_i k_i = T_i,$$

where k_i is the capital tax base administered by region i. The parameter ρ_i depicts the part of the tax revenue which is rightfully declared and assessed.

Assuming that local governments can freely choose the intensity of audits and tax enforcement the parameter ρ_i can take a value in $[0, 1]$. If the value of the parameter ρ_i is lower than one the statuary tax rate τ differs from the effective tax rate, $t_i = \tau\rho_i$. Enforcing taxes is assumed to be costless. Despite a federal-wide tax on capital with a uniform tax rate in the whole federation, local governments may engage in inter-jurisdictional tax competition, if they have some latitude of discretion to cut the effective tax burden by adjusting enforcement activities.

In the following we describe an environment in which local governments have incentives to attract mobile tax bases from neighboring regions that is similar to the frame of the model in the third chapter. We assume that each jurisdiction is endowed with an inelastic supply of one unit of a fixed factor labor. The total capital stock in the federation $\bar{K}$ is exogenously given and capital is perfectly mobile across jurisdictions, so that capital in each jurisdiction earns the same net return r. Jurisdictions intend to maximize local welfare characterized by the following quasi-linear utility function:

$$U_i(x_i, z_i) = V_i(z_i) + x_i, \tag{6.1}$$

where x_i is the private good supply and z_i is local public good provision. Preference are identical in all households of the federation.

Output is produced by local firms in each region. The aggregate CES-production function is expressed in intensive-form and crucially depends on the state of technology in the region as follows: $f(k_i, a_i)$, where k_i denotes the labor-capital ratio and a_i is a technology parameter that expresses the efficiency of local industries. In line with Bucovetsky and Smart (2006) we consider a local production technology with the following specific functional form:

$$f(k_i, a_i) = f(k_i/a_i)$$

and

$$\sum_{i=1}^{n} a_i = n.$$

The parameter a_i may take a high value a_H or a low value a_L. Markets are perfectly competitive and the production factors are therefore priced at their marginal productivity as follows: $f_k(k_i, a_i) = \phi_i$ and $f(k_i, a_i) - k_i f_k(k_i, a_i) = w_i$, where $\phi_i = r + t_i$ defines the user cost of capital consisting of interest payments and effective burden of unit capital cost. The price for the fixed factor in region i is w_i.

We assume that region-specific types are private information to local jurisdictions and local firms. Local governments can better estimate the value of capital on the local level and the efficiency of local production technologies due to the proximity of on-site problems. From an outside view, types are independently drawn from a commonly known distribution $Prob(a_i = a_H) = p$ and $Prob(a_i = a_L) = 1 - p$ respectively.

In line with chapter 3 and 4 factor prices adjust to clear markets, i.e. $\sum_{i=1}^{n} k_i = \bar{K}$. As the federal capital stock is exogenously given it follows from market clearing that $k_i' + \sum_{j=1}^{n} k_j' \frac{\partial r}{\partial t_i} = 0$ with $k_i'(\phi_i) = \frac{1}{f_{kk}(k_i)}$. Therefore, a change in the effective tax burden t_i implies a change of the net return of capital by

$$\frac{\partial r}{\partial t_i} = -\frac{k_i'(r + t_i)}{\sum_{j=1}^{n} k_j'(r + t_j)} < 0. \tag{6.2}$$

Furthermore, some capital flows out of a region and is employed in neighboring regions.

$$\frac{\partial k_i}{\partial t_i} = \frac{1}{a_i f_{kk}(k_i)} \left(1 + \frac{\partial r}{\partial t_i}\right) < 0 \qquad \text{and} \qquad \frac{\partial k_j}{\partial t_i} = \frac{1}{a_j f_{kk}(k_j)} \frac{\partial r}{\partial t_i} > 0. \tag{6.3}$$

For the sake of clarity and without loss of generality for analysis of the optimal transfer scheme we assume that the elasticity of the the tax base is identical in each region, although the absolute factor demand may certainly differ in the

case of heterogenous a_i.[1] According to the specific functional form assume in this chapter capital demand is given by:

$$k_i(\phi_i) = a_i f_k^{-1}(\phi_i), \qquad \text{with} \quad \sum_{i=1}^{n} a_i = n.$$

Hence given identical user costs of capital ϕ the tax base elasticity for region j and i is identical:

$$\frac{\partial k_i}{\partial \phi_i}\frac{\phi_i}{k_i} = \frac{\partial k_i}{\partial \phi_j}\frac{\phi_j}{k_j} = \frac{1}{f_{kk}}$$

The factor demand as well as production output crucially depend on the region-specific technology parameter a_i: Regions with a high production parameter have a high output, a high capital demand, and consequently a high capital tax base.

Households' total income is composed of wage income and capital income and is spent for private good consumption x_i:

$$x_i = w_i + r\bar{k}, \tag{6.4}$$

where $\frac{\bar{K}}{n} = \bar{k}$ is an identical share of capital held by each household. The local government's budget for local public good supply

$$z_i = t_i k_i + s_i \tag{6.5}$$

is composed of the capital tax revenue and a federal transfer s_i, not necessarily positive.

6.2.2 Federal government objective

A widespread phenomenon in many federal states such as Germany is that fiscal disparities across regions are fully equalized by a system of federal transfers in order to guarantee an equal provision of public goods. There may be two reasons for why the insurance constraint is exogenously given. First, an equal

[1] In the general case we assume that f is a monotonously decreasing function of a.

living standard is warranted by constitutional law, so that the fiscal disparities are to be equalized, and, secondly, in Germany fiscal relations between the local and federal level are coordinated in the so-called Financial Planning Council. In this Council, full tax sharing between the local governments can be regarded as a consensus found between the ministers of Finance of the provinces and the federal level. In the frame of this model, the following insurance constraint can be introduced:

$$\bar{z} = z_L = z_H, \tag{6.6}$$

so that each jurisdiction disposes of an equal supply of public goods.

6.2.3 First best optimal tax policy

The first-best optimal effective tax burden $t_i = \tau_i \cdot \rho_i$ which maximizes overall federal welfare is given as follows:

$$\max_{t_i} \sum_{i=1}^{n} V_i(\bar{z}) + x_i, \quad with \quad \bar{z} = \frac{1}{n} \sum_{i=1}^{n} t_i k_i$$

The first order conditions are:

$$k_i - \sum_{i=1}^{n} \frac{\partial r}{\partial t_i}(\bar{k} - k_i) = V_z(\bar{z}) \left\{ k_i + \sum_{i=j}^{n} t_i \frac{\partial k_j}{\partial t_i} \right\} \quad \forall i. \tag{6.7}$$

Taking into account that households have identical preferences in the whole federation, i.e. that $V_z^i(\bar{z}) = V_z^j(\bar{z}) = V_z(\bar{z})$ holds and that there is a uniform tax base elasticity across regions the first order condition simplifies to

$$V_i(z_i) = MRS(x_i) = 1. \tag{6.8}$$

From equation (6.8) we can derive that the optimal tax rate is uniform across regions; $t_i = t_j = t$.

6.2.4 Uncoordinated policy

If local governments can freely choose local enforcement activities local governments play a tax competition game by strategically choosing related policy

instruments. In a federal state with no government intervention, all regions fear the flowing out of mobile capital and exert inefficiently low enforcement activities in order to reduce the user cost of capital ϕ_i. Similar to the framework in the third chapter local governments are in a prisoners' dilemma as it would be beneficial for all regions to raise higher effective taxes. Nonetheless, unilateral deviations from the equilibrium policy through the increases of tax rates is never beneficial as it results in an important loss of local tax base.

De facto local governments try to attract capital by strategically choosing local enforcement activities, however, for notational simplicity, we depict a game in which local governments choose the effective tax burden t_i. Then the competition for mobile tax base can be displayed by the following normal form game with similar structure as in chapter 3 and 4, however with an set of strategies containing effective tax burdens:

$$\Gamma = \langle N, (t_i)_{i\epsilon N}, (U_i)_{i\epsilon N} \rangle,$$

where $N = \{1, 2, ..., n\}$ is the set of jurisdictions and $t_i = (\tau \cdot \rho_i)\epsilon\Re_+$ the set of strategies of i. Assuming Nash strategies jurisdiction i pursues a local welfare maximizing tax policy t_i, given the tax policy of its neighbors t_i. The n jurisdictions in the federation compete for mobile capital $k_i(\phi_i)$ by a strategic tax policy decision. Given its region-specific technology, the local governments optimally respond to the tax policy decisions of the other regions. This is depicted by the best response function of i:

$$BR_i(t_{-i}) = \arg\max_{t_i} \quad V_i\left(z_i\right) + x_i \quad \text{for all } i.$$

$$\text{s.t.} \quad k_i t_i = z_i$$

$$w_i + r\bar{k} = x_i$$

The system of first order conditions yields:

$$V_z(z_i)\left(k_i + t_i\frac{\partial k_i}{\partial t_i}\right) = k_i + \frac{\partial r}{\partial t_i}\left(k_i - \bar{k}\right). \tag{6.9}$$

The local government under-provides public goods with respect to the Samuelson condition as jurisdictions ignore the positive external effects of a tax policy change on other regions. Therefore, they raise inefficiently low tax rates and under-provide public goods.

6.3 Full information policy:

In this section we assume that all relevant parameters are public information. The central government can offer grants-in-aid s_i, not necessarily positive, to the local governments before local tax policies are set. Thereby, the central government acts as a Stackelberg leader offering a transfer scheme at stage 1 before local governments choose their tax policy at *stage 2*. In order to meet the *equalization constraint* (6.6), the central government must fully adjust fiscal disparities. Hence local governments' budget after federal transfers payments are enacted amounts to

$$pt_Hk_H + (1-p)t_Lk_L = \bar{z}.$$

Full equalization can be achieved by a system of tax base equalizing grants that close the gap between the current tax bases of regions and the average *per capita* tax base in the federation:

$$s_i = \bar{T} - T_i = \left(\bar{k} - k_i\right)\frac{pt_Hk_H + (1-p)t_Lk_L}{pk_H + (1-p)k_L},$$

where $\bar{t} = \frac{pt_Hk_H+(1-p)t_Lk_L}{pk_H+(1-p)k_L}$ is the average tax rate in the federation and $\bar{T} = \bar{t}\cdot\bar{k}$ is the respective average tax revenue.

We can show that a simple equalizing grant can correct for fiscal externalities. By cutting effective taxes, local governments can attract a mobile tax base

that mitigates the loss of lower tax rates. However, with tax base equalizing, there is a countervailing effect correcting the external effects of tax competition. Additional tax revenue attracted by low tax rates proportionally reduces the entitlement for equalizing grants. Consequently, fiscal externalities are internalized by tax base equalizing.

Proposition 11 *The federal government can fully equalize fiscal disparities and equally provide first best optimal tax incentives.*

Proof: In agreement with Bucovetsky and Smart (2002), the marginal effect of a tax policy change on the equalizing grant internalizes fiscal externalities. The marginal equalizing grant outweighs the following marginal capital outflow:

$$\frac{\partial s_i}{\partial t_i} = \frac{\sum_j k_j \left(k_i + \sum_j \frac{\partial k_j}{\partial t_i} t_j\right) - \sum_j \frac{\partial k_j}{\partial t_j} \sum_j t_j k_j}{\sum_j k_j^2} (\bar{k} - k_i) - \frac{\partial k_i}{\partial t_i} \bar{t} \qquad (6.10)$$

By equation (6.6), local governments dispose of the same budget and provide an identical amount of public goods, i.e. $V_z(t_L k_L + s_L) = V_z(t_H k_H + s_H)$ holds. Furthermore, local governments raise uniform taxes as the elasticity of the factor demand with respect to prices is identical in each region. Hence, equation (8) may be simplified to

$$\frac{\partial s_i}{\partial t_i} = \frac{\partial r}{\partial t_i} \left(\bar{k} - k_i\right) - \frac{\partial k_i}{\partial t_i} \bar{t}.$$

q.e.d.

In a full information case, the central government can fully equalize tax base differences and equally corrects for external effect of tax competition. By increasing the tax rate, a part of the mobile tax base flows out of the regions. However, it equally induces an increase of equalizing grants. This countervailing effect reduces fiscal externalities. Hence, the first best optimal tax policy can be restored by equalizing grants. As a second effect, independent of the direct tax base effect, tax base equalizing internalizes pecuniary externalities. Capital

exporting regions prefer lower tax rates more than their capital neighbors do. The increase of interest rates caused by a tax cut would be beneficial for tax exporting regions. This effect will also be internalized, as the average tax rate $\bar{t}$ adjusted in the appropriate way. In summary, the tax back effect depicted by equation (8) fully corrects fiscal externalities and public goods are supplied with respect to the Samuelson condition.

$$V_i(z_i) = MRS(x_i) = 1$$

6.4 Tax Base Equalizing with Adverse Selection

In this section we turn to a federal state with an asymmetric information structure. In particular, we assume that the central government cannot observe local tax bases. The central government can neither estimate the capital employment of firms via the technology parameter a_i nor evaluate effort exerted by local tax authorities to enforce taxes.[2] All in all, the central government only has knowledge about the tax revenue and can form beliefs with respect to the technology types as the distribution over a_i is public information. As local governments can peruse a low enforcement policy, the tax revenue does not necessarily reflect the true fiscal power of the region.

The timing of the game is now as follows: At stage 0, local governments privately learn their information types a_i. From an outside view types are drawn by nature from the commonly known distribution of types. In analogy to section 6.3 the central government offers a transfer scheme at *stage 1*. Different from the game in section 6.3, the central government is now ignorant of local types a_i. At *stage 2*, local governments choose their tax enforcement policy. However, in the incomplete information environment, they have incentives to mispresent the

[2]The central government cannot estimate the capital tax base by using data of local wage income as it would be possible in this simple model. In a more complex economy with different wage rates and several influencing factors on the wage rate this is not possible any more.

size of the tax base in order to substitute tax revenue for higher grants-in-aid.

As fiscal disparities are fully equalized local governments can only affect private good consumption by manipulating enforcement activities. Indeed, in the set up of our model a higher effective tax burden goes along with lower private good consumption in the respective region. Therefore we can derive that high-type regions have an incentive to reduce effective tax rates by mispresenting the true size of the tax base. On the contrary, low type regions have no incentives to increase the local tax burden by mimicking high type regions. Therefore low type regions have no latitude of discretion to exploit the common pool by mispresenting privately known local data.

Local governments with a high type may cut *effective* tax rates e.g. by lowering enforcement activities until they dispose of the same tax revenue as less efficient neighbors. We define the tax revenue of efficient local governments that mimic a low type as $\tilde{k}_{iH}\tilde{t}_{iH}$, with

$$a_H f_k^{-1}\left(r+\tilde{t}_H\right)\tilde{t}_H = a_L f_k^{-1}\left(r+t_L\right)t_L \quad \Longleftrightarrow \quad \tilde{t}_H\tilde{k}_H = k_L t_L. \tag{6.11}$$

If the central government intends to provide optimal incentives for tax enforcement on the local level, it must take into account the informational constraints. We design an incentive-compatible transfer scheme so that local governments refrain from substituting tax revenue for higher grants-in-aid.

$$\hat{\Gamma} = \langle N, (t_i(a_i, a_{-i}))_{i\epsilon N}, (s_i(a_i, a_{-i}))_{i\epsilon N}, \times_{i=1}^{n}\{a_L, a_H\}\rangle.$$

In particular, it should not be profitable by high-type regions to choose an untruthful enforcement policy, so that the following incentive-compatibility constraint must be fulfilled:

$$V_i\left(t_H k_H + s_H\right) + x_H \geq V_i\left(t_L k_L + s_L\right) + \tilde{x}_H. \tag{6.12}$$

Adding up equation (6.12) and the insurance constraint (6.6) it becomes obvious that the the incentive-compatibility constraint holds if the the private good consumption for high types cannot be increased by an untruthful policy, i.e. the value must of $\tilde{x}_H$ must exceed the value of x_H. Thus, the central government pays additional grants to high-type regions supporting their private sector and increasing private good consumption:

$$l_i(t_i) = np\left(\tilde{x}_H(t_i) - x_H(t_i)\right).$$

The information rent l_i mitigates the scope for federal redistribution so that the budget of local governments after tax base equalizing is lower than in the full information case derived in section 3:

$$\bar{z} = pt_H k_H + (1-p)t_L k_L - p[\tilde{x}_H - x_H] \tag{6.13}$$

The optimal transfer system should provide optimal tax incentives as well as minimize informational costs l_i. The welfare-maximizing equalizing grant is defined by:

$$(\hat{t}_1, ..., \hat{t}_n) = \arg\max \sum_{i=1}^{n} V_i(\bar{z}) + x_i, \quad with \tag{6.14}$$

$$\bar{z} = \frac{1}{n}\left(\sum_{i=1}^{n} t_i k_i - l_i(t_i)\right)$$

The first order conditions are:

$$k_i - \sum_{i=1}^{n} \frac{\partial r}{\partial t_i}(\bar{k} - k_i) = V_z(\bar{z})\left\{k_i + \sum_{i=j}^{n} \hat{t}_i \frac{\partial k_j}{\partial t_i} - \frac{\partial l_i(\cdot)}{\partial t_i}\right\} \quad \forall i. \tag{6.15}$$

In the full information case no information rents are payed so that a uniform tax rate is raised in high and low type regions as it is depicted in equation (6.8). However in federations with asymmetric information the federal government may distort incentives for enforcement policy away from the first best if a change of the effective tax burden may have an impact on informational rents. In the

following we depict the marginal effect of an increase of the effective tax burden on the information rent l_i for high type and low type regions respectively:

$$\frac{\partial l_i}{\partial t_H} = \left\{ k_H + \frac{\partial r}{\partial t_H}(\bar{k} - k_H) \right\} \tag{6.16}$$

$$\frac{\partial l_i}{\partial t_L} = \frac{d\tilde{t}_H}{dt_L} \left\{ k_L + \frac{\partial r}{\partial t_L}(\bar{k} - k_L) \right\}, \tag{6.17}$$

The central government must concede an information rent to high type regions which must be at least as high as the surplus of private income $\tilde{x}_H - x_H$ in the case of enforcement dumping. Indeed, informational costs can be reduced if the difference between $\tilde{x}_H$ and x_H is relatively small.

Providing more *high-powered* incentives for local enforcement activities in high type regions leads to an increase of private good consumption in regions which enact a truthful policy x_H and hence reduce informational cost. Further we can derive an indirect impact of low types' enforcement policies on the incentive scheme of high types: if low type regions dispose of a relatively high tax revenue, high type regions' latitude to engage in enforcement dumping is reduced. By equation (6.11) hight type regions can cut effective tax rates until condition $t_L k_L = \tilde{t}_H \tilde{k}_H$ holds, so that $\tilde{t}_H$ will increase if t_L is augmented.

Thereby, one has to take into account two effects: Primarily, there is a real trade-off between equity and efficiency, so that the federal government can reduce informational costs by distorting incentives for enforcement activities so that tax rates differ across high type and low type regions. As a consequences of tax differences the central government must take into account the pecuniary externalities, which we have already derived in the third chapter.

Overall, the federal government gives incentives for a local tax policy, where at the margin the welfare gain of increased rent extraction and the welfare loss of an incomplete internalization of fiscal externalities are balanced. Concavity of

the welfare function ensures that it is always profitable to distort tax incentives in two ways because it results in a more efficient mix of private and public goods.

Proposition 12 *In a second best tax policy setting optimal grants provide inefficiently high tax incentives in high type regions and in efficiently low tax incentives in low type regions.*

Let us consider a transfer scheme depending on the local tax revenue. In line with the full information policy the central government offers a tax base equalizing program that equalizes the gap between below average and above average:

$$S_i(t_i) = m_i + l_i + b_i(\bar{T} - T_i),$$

where l_i are lump-sum grants offered to local governments in the form of a subvention for the private sector in the region i. A second lump-sum payment

$$m_i = 1 - b_i \left(\bar{T} - \hat{T}_i\right),$$

is necessary to meet the full insurance constraint, where $\hat{T}_i$ is the second best optimal tax revenue. The degree of revenue sharing b_i is derived by decomposition of equations (6.15) to (6.17).

Therefore, the weight b_i is lower than one for high types and higher than one for low types so that tax bases differences are either partially equalized or over-compensated, respectively. The central government can extract a part of informational rents by offering a system of grants that under-compensate tax base differences for high types and under-compensate differences for low types. Partly equalized tax base differences in high type regions go along with a small tax back effect. Accordingly, the tax burden for the private sector is lower than in the first best case because of the incomplete internalization of externalities. Over-compensating tax differences in the low type regions provides high tax incentives.

Proposition 13 *In the second best policy, the central government offers a system of grants that entails a low tax back effect for high types by partially equalizing. In contrast, grants for low types over-compensate tax base disparities and therefore go along with an important tax back effect.*

6.5 Incentive Effects of Tax Base Equalizing

In many federal states the central government pays grants to reduce fiscal disparities among local jurisdictions in a federal state. We have shown in agreement with Bucovetky and Smart (2006) that tax base equalizing grants entail a tax raising effect on the local level. In the full information case a tax back effect of tax base equalizing internalizes fiscal externalities and ensures efficient tax incentives on the local level.

In section 6.4, we have turned to a contact-specific environment with asymmetric information. Local governments' enforcement activities are unobservable by the central government. Moreover, the central government can hardly ascertain if local governments dispose of a high or low capital tax base. Therefore, local governments may have incentives to choose an excessively lax enforcement policy in order to lower the tax burden for local firms. A decline of tax revenue can be substituted by higher equalizing grants. Consequently, tax base equalizing with asymmetric information can be a source of inefficiencies itself.

In order to tackle the adverse selection problem, the central government can offer truthful transfer mechanisms that provide optimal incentives for local tax policy as well as enforcement policy. Moreover, the differences between local tax bases are balanced by tax base equalizing. In order to achieve incentive-compatibility, the central government must offer a positive information rent to local governments which mitigates the scope for federal redistribution.

We have shown that the central government can reduce informational cost by offering a transfer scheme with a two way distortion differing from the solutions

presented in the foregoing chapters. The reason for the incongruity of this result with the optimal transfer scheme derived in chapter 3 lies in the specific assumptions with respect to the insurance constraint. In this chapter we have assumed that public good supply is fully equalized so that local governments try to manipulate enforcement activities in order to augment private good consumption. Besides, we have shown in the analysis that it emerges to be welfare enhancing to distort as well high types away from the first best. In contrary in chapter 3 and 4 we have consider a setting where the central government compensates differences in local welfare. We have demonstrated that in this context no informational rent can be extracted if the central government implements higher tax rate in θ_H-type regions.

Chapter 7

Internalizing Interregional Spillovers[1]

7.1 Schemes to Combat Transboundary Spill Overs

Together with tax competition interjurisdictional externalities of spillovers of local governments' provision of public goods are probably the main concerns raised by interregional competition. As a stylized feature in many federal settings the policy enacted by a particular local government is not completely localized. However, if constituents of other jurisdictions cannot be excluded from local public good supply provided in a particular region a spillover problem arises. In contrast to the tax competition game explored in chapter 3 and 4 we here consider a setting where the marginal cost of public funding are correctly internalized but the local marginal benefits of public good provision do not reflect overall welfare considerations.

Likewise the theory of fiscal federalism has well understood, that local public goods may be supplied inefficiently if local government act in the interest of their constituents not taking into account positive interregional externalities; see Oates (1972). Wellisch (2000) has pointed out that matching grants from the central government can be used to correct misguided local governments' incentives. Nevertheless in the latter four chapters we have demonstrated that an

[1]This chapter has been taken from Altemeyer-Bartscher, Rübbelke and Sheshinski (2009).

appropriate system of matching grants ask for full information and considerably strong commitment devices in the hands of the central authority.

In this chapter we are going to consider a federal system in the absence of a central authority that may enforce environmental regulations on the local level. In this case voluntary interregional agreements are considered to be most capable of generating a more efficient provision of local public goods and services. Deviant from the foregoing chapters we now consider a setting with full information. A good example of use for this specific setting characterized by interregional spillovers and a lack of a strong central authority may be trans-boundary environmental damages on an international scale. In particular the threats of the climate change have become a main issue on the political agenda of many countries. As a matter of course any policy which mitigates global warming can be interpreted as a global public good characterized by non-rivalness and non-excludability.

One of the most prominent examples of international environmental agreements is the Kyoto Protocol which contains rules for climate protection by using a quantity based approach. In recent political discussions this approach gives reasons for fierce disputes about the best way to combat global warming. This holds even more since the Kyoto Protocol expires in 2012 and a new international regulation - a post-Kyoto mechanism - has to be found.

Nordhaus (2006) proposed an price-based international incentive scheme to internalize transboundary environmental external effects. This may serve as a proper successor of the quantity approach of the Kyoto type. Nordhaus (2006, p. 32) has pointed out: "This is essentially a dynamic Pigovian pollution tax for a global public good". Due to the reduction of greenhouse gases an international externality correcting tax scheme, which does not impose any restrictions on

international emission is considered to have several significant advantages over the Kyoto mechanism. Nordhaus highlights that this scheme could also contain side-payments in order to motivate countries to participate.[2] In this spirit we are going to investigate a price-influencing scheme and show how local governments or countries could negotiate the design of an international Pigouvian tax scheme in a decentralized way. Evidently, decentralized bargaining is necessary in regime in which no taxing power is assigned to a central global authority. In particular we suggest schemes that allow for reciprocal interregional side-payments contingent on the level of the environmental tax rates implemented in the transfer-receiving opponent country. For simplicity we focus on a world consisting of two regions which enter into mutual negotiations. We investigate whether our scheme could Pareto-improve the outcome in global environmental protection or even generate a Pareto-efficient result.

In line with Rübbelke and Sheshinski (2005) we analyze the effects of taxes and transfers on the level of externalities. However, our analysis differs significantly from their investigation, since ours deals with reciprocal global externalities while their analysis considers asymmetric unilateral international externalities with limited geographical impact. The asymmetry they consider is an element which is in some sense equivalent to the desire to redistribute in Sheshinski (2004). In Sheshinski's analysis the tax on the externality-generating good contains a uniform component (efficiency factor) and a component that varies across households and reflects an income redistribution objective (redistributive factor). In contrast to Sheshinski (2004), the asymmetry in the model suggested by Rübbelke and Sheshinski (2005) just results from an asymmetric distribution of pollution. In analyzing the asymmetric international regional problem they

[2] "Additionally, poor countries might receive transfers to encourage early participation", Nordhaus (2006, p. 32).

combine the ideas of Coase (1960) and Pigou (1932) of solving externality problems. In our investigation of global environmental problems we revive this idea of combining the ideas of Coase (1960) and Pigou (1932).

An important advantage of the mechanism is that there is no need for a central authority to regulate environmental policy. In practice there is in general a low willingness of regional governments to give away power to a central authority; see Falkinger, Hackl and Pruckner (1996). Furthermore, a simple scheme of mutual side-payments is easy enough to be understood by local authorities. In particular, it emerges to be difficult in real word applications to determine a baseline against which countries set their environmental policy. Nordhaus (2006) points out that especially quantity limits are troublesome because of different economic growth and heterogeneous technological circumstances across regions. However, in this chapter the baseline of environmental policy is simply the individual rational environmental tax raised by regional decision makers. Local governments' eco-tax policy is evaluated relative to its baseline, so that the opponent does only pay transfers for the internalization of transboundary externalities.

In particular in our analysis we formulate an incentive-compatibility constraint which must been met in order to assure that local governments commit themselves to cooperate with neighboring regions. Thereby we propose a mechanism which in line with Guttman (1978, 1987), Danziger and Schnytzer (1991) as well as Guttman and Schnytzer (1992) neither postulates any property right on pollution nor requires any negations prior to the game played. Many solutions to the free-rider problem call for coercion in order to internalize transboundary external effects. Here, local governments are free to raise eco-taxes so that the take-it-or-leave-it offer must meet the aforementioned individual rationality con-

straint. As a distinctive feature of this chapter to the existing literature we consider economies in which the efficient allocation of private goods is implemented by an eco-tax. The eco-tax revenue is then used to finance the side-payments to correct for transboundary externalities which stem from the neighboring country. Hence, the suggested policy generates a double environmental dividend. Firstly, the regional eco-tax internalizes transboundary external effects by correcting relative prices on a regional scale. Secondly the tax revenue of the eco-tax can be used to finance side-payment to achieve stable interregional agreement in the neighboring country. We show that local governments overcome the free-rider problem by means of the tax-transfer scheme - a first-best optimum can be set up.

With respect to the literature, several contributors have analyzed the internalization of reciprocal externalities by means of a transfer mechanism. Oates (1972) as well as Wellisch (2000) examines the problem of reciprocal externalities in the provision of local public goods arising in a federal state. He analyzes the design of federal grants which achieve an efficient allocation in the federation. Buchholz and Konrad (1995) investigate the impact of strategic transfers on the private provision of public goods. Yet, the transfers they regard are of an unconditional type. Barrett (1995) suggests collecting funds from industrialized countries in order to finance greenhouse gas abatement in developing countries. Therefore, the funds are transferred in a conditional way. Barrett (1995) recommends to collect these funds by means of a matching scheme - like the one suggested by Guttman (1978, 1987), because this scheme reduces the industrialized countries' incentives to take a free ride. Gersbach and Winkler (2007) propose a global refunding scheme to internalize international environmental spillovers. Similar to our paper they design an international tax scheme

that may at least partly self-finance side-payments to achieve stable agreements. Different to our paper however they consider a short-cut abatement model in accordance with Falk and Mendelsohn (1993) focusing on dynamic stability of the scheme. Of course the results crucially depend on the information structure predominant in the game. In a setting with a global environmental facility scheme John and Rübbelke (2007) have pronounced, that local governments may have incentives to mispresent their propensity to protect the global environment in order to receive higher grants in aid. In this case we face a similar problem of adverse selection as it is exposed in chapter 3 to 6.

Although the analysis of stable environmental coalitions is an important one, our analysis does not consider coalition formation. Instead we regard countries non-cooperatively choosing their environmental protection levels by comparing their marginal effective cost and benefits of environmental protection.

In this chapter we proceed as follows: In Section 7.2 we suggest a tax-transfer scheme to overcome inefficiencies and we present the features of our model. Section 7.3 is dedicated to the special case of a one-sided spillover. In Section 7.4 we extend the analysis to the case of reciprocal externalities. Finally, Section 7.5 concludes.

7.2 The Basic Model

7.2.1 Transboundary Pollution Spillovers

In this chapter we consider a setting with two regions indexed by $(i = 1, 2)$ which both sustain losses from interregional environmental damages. Different to the foregoing chapters there is no central government with the power to intervene in the case of local policy shortfalls. In jurisdiction i a representative household consumes a private good which amounts to x_i. The production of x_i accompanies environmental damages. Further, the household consumes a *clean*

private good of the amount y_i which is not associated with an externality. It is assumed that households behave competitively, i.e., they ignore their own effect on total pollution. Furthermore, they take the other agents' pollution levels as given. The total environmental externalities perceived in jurisdiction i amount to $\phi = (X_1, X_2)$, where X_1 represents the total amount of the pollution-generating private good consumption in jurisdiction 1 and X_2 is the respective consumption in jurisdiction 2. An eco-tax in the shape of an excise tax is levied which burdens the consumption of the polluting commodity.[3]

7.2.2 The Individual Household's Maximization Problem

The maximization problem of a representative household in jurisdiction i can be expressed as follows:

$$\max_{x_i, y_i} u_i(x_i, y_i, \phi) \tag{7.1}$$

$$s.t. \quad (p + t_i)x_i + y_i = m_i + \tau_i - \sigma_i,$$

where m_1 denotes the level of the representative household's income, t_i denotes the excise tax rate, $\tau_i = t_i x_i$ stands for the tax funds raised from the representative household and σ_i is the amount of tax funds i redistributed to others, such that $\tau_i - \sigma_i$ is the amount of tax funds which the representative household gets back from its government. It is assumed that the households are naive, i.e., they do not consider the effects of their behavior on τ_i and σ_i. This is plausible because the impact of a single household on the rest of the world is negligible.

We obtain the following first-order conditions:

$$\frac{\partial u_i}{\partial x_i}(x_i, y_i, \phi) - \lambda(p + t_i) = 0, \tag{7.2}$$

$$\frac{\partial u_i}{\partial y_i}(x_i, y_i, \phi) - \lambda = 0, \tag{7.3}$$

[3] "In the case of reciprocal consumption externalities, the common interpretation of the Pigouvian principle calls for taxes on the externality-creating commodities" (Green and Sheshinski (1976: 798)).

$$px_i + y_i - m_i + \sigma_i = 0. \tag{7.4}$$

7.2.3 Take-it-or-leave-it Offer

Regional welfare maximizing decision makers in jurisdiction i do not take into account negative external effects they exert on neighbouring jurisdiction j ($j = 1, 2$ and $j \neq i$) and hence raise inefficiently low eco-taxes on the consumption of the dirty good x_1. One method of coordinating environmental policy among regions to overcome inefficiently high transnational externality production is the implementation of a system of international side-payments. We assume that each jurisdiction can make a take-it-or-leave-it offer. Jurisdiction i, for example, could offer (S_j, t_j) , i.e. jurisdiction i offers a transfer payment S_j which is channeled to jurisdiction j in order to induce this jurisdiction to raise its eco-tax rate t_j to a certain level desired by i. Jurisdiction j can either accept or reject the offer. We assume that both countries can make binding commitments with respect to their transfer payment and eco-tax levels. Local governments simultaneously offer take-it-or-leave-it contracts. In doing so, each jurisdiction anticipates the subject matter (S_k, t_k) , with $k = i, j$, of the contract offered by the opponent.

7.2.4 The First-best Policy

As a reference we examine the maximization problem of a social planner who maximizes global welfare, i.e. the sum of both countries' welfare. We suppose that a jurisdiction's welfare level is equal to the sum of the welfare levels enjoyed by the individual households located in the respective jurisdiction:

$$\max_{X_1, X_2} W = U_1(X_1, \phi) + U_2(X_2, \phi)$$

$$s.t. \quad p(X_1 + X_2) + Y_1 + Y_2 = M,$$

where $M = M_1 + M_2$ denotes the sum of national income M_1 in jurisdiction 1 and of national income M_2 in jurisdiction 2. The first order conditions writes:

$$\frac{\partial U_1}{\partial X_1} + \frac{\partial U_1}{\partial \phi}\frac{\partial \phi}{\partial X_1} + \frac{\partial U_2}{\partial \phi}\frac{\partial \phi}{\partial X_1} = p\lambda, \tag{7.5}$$

$$\frac{\partial U_2}{\partial X_2} + \frac{\partial U_2}{\partial \phi}\frac{\partial \phi}{\partial X_2} + \frac{\partial U_1}{\partial \phi}\frac{\partial \phi}{\partial X_2} = p\lambda, \tag{7.6}$$

where the third terms on the LHS of (7.5) and (7.6) respectively denote the marginal external effects of pollution. From equations (7.5) and (7.6) as well as equation (7.7) we obtain the Pareto-efficient tax rates:

$$t_1^{fb} = \frac{\frac{\partial U_1}{\partial X_1}}{\lambda} - p = -\frac{\frac{\partial U_1}{\partial \phi}\frac{\partial \phi}{\partial X_1} + \frac{\partial U_2}{\partial \phi}\frac{\partial \phi}{\partial X_1}}{\lambda}, \tag{7.7}$$

$$t_2^{fb} = \frac{\frac{\partial U_2}{\partial X_2}}{\lambda} - p = -\frac{\frac{\partial U_2}{\partial \phi}\frac{\partial \phi}{\partial X_2} + \frac{\partial U_1}{\partial \phi}\frac{\partial \phi}{\partial X_2}}{\lambda}. \tag{7.8}$$

The first-best optimal eco-tax policy (t_1^{fb}, t_2^{fb}) fully internalizes pollution externalities.

7.3 Unilateral Externalities

In this section we consider the special case of a one-sided pollution spillover-effect from jurisdiction 2 to jurisdiction 1. We assume that pollution is produced in both countries but it only affects welfare in jurisdiction 1, i.e. for $\phi(X_1, X_2) > 0$ with $X_1, X_2 > 0$ it follows $\frac{\partial U_1}{\partial \phi} < 0$ and $\frac{\partial U_2}{\partial \phi} = 0$. One can think of the case that jurisdiction 2 can easily adapt to the adverse effects of the global warming problem, while it will cause an important loss in jurisdiction 1. Schelling (1992: 4-7), for example, pointed out that climate change would entail higher costs in countries with an important agriculture sector, while industrial states

are less vulnerable to global warming.[4] Thus, jurisdiction 2, which does not internalize consumption externalities in jurisdiction 1, has no incentives to raise a positive eco-tax on the consumption of good X_2. However, jurisdiction 1 raises taxes which fully internalize the adverse effects of consumption as there are no transboundary spillover-effects.

7.3.1 The Relationship between Taxes and Transfers

The government of jurisdiction 1 intends to induce jurisdiction 2 to raise an eco-tax. Therefore it offers a take-it-or-leave-it offer which fulfills the following individual-rational condition:

$$U_2(X_2(t_2, S_2), Y_2(t_2, S_2)) = U_2(X_2(0,0), Y_2((0,0))), \tag{7.9}$$

Jurisdiction 2 will accept jurisdiction 1's offer if the its utility level before the tax (LHS) has to be at least as high as its welfare after implementation of the eco-tax (RHS). The utility level U of a jurisdiction is assumed to be simply equal to the sum of the utility levels of its households and is described by indirect utility functions as employed in (7.1). After taking into account the first-order conditions of the households' decision problem (7.2) and (7.3) and the differentiation of the sum of all households' budget constraints in jurisdiction 2, which is

$$p\left(\frac{\partial X_2}{\partial t_2} + \frac{\partial X_2}{\partial I_2}\frac{dS_2}{dt_2}\right) + \frac{\partial Y_2}{\partial t_2} + \frac{\partial Y_2}{\partial I_2}\frac{dS_2}{dt_2} = \frac{dS_2}{dt_2}, \tag{7.10}$$

[4] Yet, mainly in developing countries the agricultural sector constitutes a main part of the economy and these countries are unlikely to pay positive net transfers to the developing world. "Poorer countries are probably more vulnerable to climate change than wealthier countries" (Schelling (1995: 401)). And as the IPCC (1998: 8) stresses: "Africa is the continent most vulnerable to the impacts of projected changes because widespread poverty limits adaptation capabilities."

we obtain after some mathematical manipulations:

$$\frac{dS_2}{dt_2} = -\left(\frac{t_2}{1 + t_2 \frac{\partial X_2}{\partial I_2}}\right) \frac{\partial X_2}{\partial t_2} > 0. \tag{7.11}$$

Thereby I_2 represents the jurisdiction's national income. By the individual rationality constraint (7.9) jurisdiction 1 must compensate jurisdiction 2 for the loss of regional welfare induced by the eco-tax . Consequently the transfer from jurisdiction 1 to jurisdiction 2 has to be the higher, the higher the tax in jurisdiction 2 desired by jurisdiction 1.

7.3.2 Jurisdictions' Choices

The government of jurisdiction 1 intends to maximize regional welfare. It raises an eco-tax rate on home consumption and induces the implementation of an eco-tax in the neighbouring jurisdiction 2 by take-it-or-leave-it contract as well. The government of the transfer paying jurisdiction 1 maximizes the following indirect utility function:

$$\max_{t_1,t_2} U_1(X_1(t_1, S_2, X_2), Y_1(t_1, S_2, X_2), \phi(X_1, X_2)), \tag{7.12}$$

where $\phi = \phi(X_1, X_2)$ represents the total amount of environmental externalities perceived in jurisdiction 1. Welfare maximization yields the tax rate t1 chosen by the transfer-paying jurisdiction's government:

$$t_1 = -\frac{\frac{\partial U_1}{\partial \phi}\frac{\partial \phi}{\partial X_1}}{\lambda} > 0 \tag{7.13}$$

The calculation of jurisdiction 1's optimal choice of the tax rate t2 in jurisdiction 2 which it influences via its transfer payments yields:

$$t_2 = \left(\frac{1 + t_2 \frac{\partial X_2}{\partial I_2}}{1 - \frac{\frac{\partial U_1}{\partial \phi}\frac{\partial \phi}{X_2}}{\lambda}\frac{\partial X_2}{\partial I_2}}\right)\left(-\frac{\frac{\partial U_1}{\partial \phi}\frac{\partial \phi}{\partial X_2}}{\lambda}\right) = -\frac{\frac{\partial U_1}{\partial \phi}\frac{\partial \phi}{\partial X_2}}{\lambda}. \tag{7.14}$$

By comparing equations (7.13) and (7.14) with the first-best optimal reference solution derived in section 2 it becomes obvious that the choices of jurisdiction 1 and therefore the tax-transfer scheme yields a Pareto-efficient outcome.

7.4 Reciprocal Externalities

Let us turn to the generalized set-up of our model with reciprocal spillover effects. Here, each jurisdiction's welfare is affected by pollution ϕ which again depends on the consumption level in both countries. Unlike the unilateral problem in Section 3, both countries will have incentives to offer a contract to their neighbour in order to influence the eco-tax policy of the opponent.

7.4.1 Relationship between Taxes and Transfers

Jurisdiction 1 makes a take-it-or-leave-it offer to jurisdiction 2. In turn, it also receives an offer by its opponent. In order to fulfill the individual rationality condition no jurisdiction should be better off by unilaterally rejecting the offer of its opponent. We claim that jurisdiction 2 will only accept to implement a tax when its utility after the tax (LHS) remains at least equal to the state before the implementation of a tax (RHS):

$$\begin{aligned} U_2(X_2(t_2^*, S_1, S_2, X_1)Y_2(t_2^*, S_1, S_2, X_1)\phi(X_1, X_2(t_2^*, S_1, S_2, X_1))) = \\ U_2(X_2(t_2^*, S_1, 0, X_1)Y_2(t_2^*, S_1, 0, X_1)\phi(X_1, X_2(t_2^*, S_1, 0, X_1))) \end{aligned} \tag{7.15}$$

where S_2 represents the sum of transfers received from jurisdiction 1. X_2 is the equilibrium amount of the polluting good consumed in jurisdiction 2 and Y_2 is the respective amount of the second private good. The LHS denotes the welfare of jurisdiction 2 if it accepts jurisdiction 1's offer (S_2, t_2^*). In case of a rejection of the offer it raises an individual rational tax t_2. Total differentiation yields

$$\begin{aligned} \left(\frac{\partial U_2}{\partial X_2} + \frac{\partial U_2}{\partial \phi}\frac{\partial \phi}{\partial X_2} + \frac{\partial U_2}{\partial X_1}\frac{\partial \phi}{\partial X_1}\frac{\partial X_1}{\partial X_2}\right)\left(\frac{\partial X_2}{\partial t_2^*} + \frac{\partial X_2}{\partial I_2}\frac{dS_2}{dt_2^*}\right) \\ + \frac{\partial U_2}{\partial Y_2}\left(\frac{\partial Y_2}{\partial t_2^*} + \frac{\partial Y_2}{\partial I_2}\frac{dS_2}{dt_2^*}\right) = 0, \end{aligned} \tag{7.16}$$

where I_2 is the net income in jurisdiction 2. When we take account of conditions (7.2) and (7.3) and the differentiation of the sum of all households' budget

constraints we can also write:

$$\left(t_2 + \frac{\frac{\partial U_2}{\partial \phi}\frac{\partial \phi}{\partial X_2}}{\lambda} + \frac{\frac{\partial U_2}{\partial \phi}\frac{\partial \phi}{\partial X_1}}{\lambda}\frac{\partial X_1}{\partial X_2}\right)\left(\frac{\partial X_2}{\partial t_2} + \frac{\partial X_2}{\partial I_2}\frac{dS_2}{dt_2}\right) + \frac{\partial S_2}{\partial t_2} = 0.$$

Rearranging yields:

$$\frac{\partial S_2}{\partial t_2} = -\frac{\left(t_2 + \frac{\frac{\partial U_2}{\partial \phi}\frac{\partial \phi}{\partial X_2}}{\lambda} + \frac{\frac{\partial U_2}{\partial \phi}\frac{\partial \phi}{\partial X_1}}{\lambda}\frac{\partial X_1}{\partial X_2}\right)\frac{\partial X_2}{\partial t_2}}{1 + \left(t_2 + \frac{\frac{\partial U_2}{\partial \phi}\frac{\partial \phi}{\partial X_2}}{\lambda} + \frac{\frac{\partial U_2}{\partial \phi}\frac{\partial \phi}{\partial X_1}}{\lambda}\frac{\partial X_1}{\partial X_2}\right)\frac{\partial X_2}{\partial I_2}}. \tag{7.17}$$

The amount of money which jurisdiction 1 must at least pay to jurisdiction 2 is uniquely determined by the choice of the tax rate t_2. In particular, S_2 is an increasing function of t_2 for all $t_2 < t_2^*$. Reciprocally, we can derive the marginal impact of t_1 on S_1.

7.4.2 Transfer-paying Jurisdiction 1's Maximization Problem

Jurisdictions 1 and 2, both intend to maximize national welfare. Counties 1 and 2 make a take-it-or-leave-it offer (S_2, t_2) and (S_1, t_1), respectively. In the simultaneous move game jurisdiction 1 can correctly anticipate (S_1, t_1) offered by jurisdiction 2 and vice versa. In the equilibrium both countries will accept the offers of their opponents respectively and we can restrict our analysis to the following maximization problem:

$$\max_{t_2} \quad U_1(X_1(t_1, S_1, S_2, X_2), Y_1(t_1, S_1, S_2, X_2), \phi(X_1, X_2)). \tag{7.18}$$

Maximization yields

$$\begin{aligned}
\frac{\partial U_1}{\partial X_1}\left(\frac{\partial X_1}{\partial I_2}\frac{dS_2}{dt_2} + \frac{\partial X_1}{\partial X_2}\left(\frac{\partial X_2}{\partial t_2} + \frac{\partial X_2}{\partial I_2}\frac{dS_2}{dt_2}\right)\right) + \\
\frac{\partial U_1}{\partial Y_1}\left(\frac{\partial Y_1}{\partial I_2}\frac{dS_2}{dt_2} + \frac{\partial Y_1}{\partial X_2}\left(\frac{\partial X_2}{\partial t_2} + \frac{\partial X_2}{\partial I_2}\frac{dS_2}{dt_2}\right)\right) + \\
\frac{\partial U_1}{\partial \phi}\frac{\partial \phi}{\partial X_1}\left(\frac{\partial X_1}{\partial I_2}\frac{dS_2}{dt_2} + \frac{\partial X_1}{\partial X_2}\left(\frac{\partial X_2}{\partial t_2} + \frac{\partial X_2}{\partial I_2}\frac{dS_2}{dt_2}\right)\right) + \\
\frac{\partial U_1}{\partial \phi}\frac{\partial \phi}{\partial X_1}\left(\frac{\partial X_2}{\partial t_2} + \frac{\partial X_2}{\partial I_2}\frac{dS_2}{dt_2}\right) = 0.
\end{aligned} \tag{7.19}$$

In order to derive jurisdiction 1's optimal choice of t_2, we insert (7.7) and (7.8) aggregated over all households in jurisdiction 1 and the derivative of the budget constraint for t_2, which is $p\frac{\partial X_1}{\partial t_2} + \frac{\partial Y_1}{\partial t_2} = -\frac{\partial S_2}{\partial t_2}$ into (7.19). Then we obtain

$$\left(t_1\frac{\partial X_1}{\partial X_2} + \frac{\frac{\partial U_1}{\partial \phi}\frac{\partial \phi}{\partial X_1}}{\lambda}\frac{\partial X_1}{\partial t_1} + \frac{\frac{\partial U_1}{\partial \phi}\frac{\partial \phi}{\partial X_1}}{\lambda}\right)\left(\frac{\partial X_2}{\partial t_2} + \frac{\partial X_2}{I_2}\frac{dS_2}{dt_2}\right) = \frac{\partial S_2}{\partial t_2}. \tag{7.20}$$

Jurisdiction 2 in turn counterbids a contract to 1 so that we can write the following system of equations:

$$\begin{aligned}\frac{\partial S_2}{\partial t_2}\left[1 - \left(t_1\frac{\partial X_1}{\partial X_2} + \frac{\frac{\partial U_1}{\partial \phi}\frac{\partial \phi}{\partial X_1}}{\lambda}\frac{\partial X_1}{\partial X_2} + \frac{\frac{\partial U_1}{\partial \phi}\frac{\partial \phi}{\partial X_2}}{\lambda}\right)\frac{\partial X_2}{\partial I_2}\right] = \\ \left(t_1\frac{\partial X_1}{\partial X_2} + \frac{\frac{\partial U_1}{\partial \phi}\frac{\partial \phi}{\partial X_1}}{\lambda}\frac{\partial X_1}{\partial X_2} + \frac{\frac{\partial U_1}{\partial \phi}\frac{\partial \phi}{\partial X_2}}{\lambda}\right)\frac{\partial X_2}{\partial t_2}\end{aligned} \tag{7.21}$$

$$\begin{aligned}\frac{\partial S_1}{\partial t_1}\left[1 - \left(t_2\frac{\partial X_2}{\partial X_1} + \frac{\frac{\partial U_2}{\partial \phi}\frac{\partial \phi}{\partial X_2}}{\lambda}\frac{\partial X_2}{\partial X_1} + \frac{\frac{\partial U_2}{\partial \phi}\frac{\partial \phi}{\partial X_1}}{\lambda}\right)\frac{\partial X_1}{\partial I_1}\right] = \\ \left(t_2\frac{\partial X_2}{\partial X_1} + \frac{\frac{\partial U_2}{\partial \phi}\frac{\partial \phi}{\partial X_2}}{\lambda}\frac{\partial X_2}{\partial X_1} + \frac{\frac{\partial U_2}{\partial \phi}\frac{\partial \phi}{\partial X_1}}{\lambda}\right)\frac{\partial X_1}{\partial t_1}\end{aligned} \tag{7.22}$$

Inserting equation (7.16) the equivalent marginal effect for jurisdiction 1 into the system of equations (7.21) and (7.22) shows that the two countries with reciprocal spillover-effects can coordinate to play a first-best optimal eco-tax policy by a system of take-it-or-leave-it offers:

$$t_1^* = \frac{\frac{\partial U_1}{\partial \phi}\frac{\partial \phi}{\partial X_1} + \frac{\partial U_2}{\partial \phi}\frac{\partial \phi}{\partial X_1}}{\lambda}$$

$$t_2^* = \frac{\frac{\partial U_2}{\partial \phi}\frac{\partial \phi}{\partial X_2} + \frac{\partial U_1}{\partial \phi}\frac{\partial \phi}{\partial X_2}}{\lambda}$$

7.5 Price Mechanisms Versus the Kyoto Protocol

Contemporarily, in the climate protection debate several different schemes are suggested to become successors of the current Kyoto scheme. Many proposals are based on a quantity approach, i.e. the targets of these schemes are certain levels for greenhouse gas abatement. In contrast, price approaches intend to

raise the effective price of pollution, e.g. by levying carbon taxes world-wide. In this chapter we focus on the analysis of the latter.

We examine a take-it-or-leave-it mechanism to combat global environmental externalities. Countries offer a contract to neighboring countries to influence these countries' eco-tax policies. The contract includes the pledge to pay an income transfer to the neighboring countries provided that these countries raise their eco-tax levels up to a level desired by the transfer-offering countries.

Welfare losses which may go along with an increase of eco-tax rates are compensated by the side-payments offered in the contracts. As a distinctive feature of this study to the existing literature we propose a mechanism in which side-payments are financed by the revenue raised by means of the eco-taxes. Therefore there exists a double environmental dividend of these eco-taxes. On the one hand global externalities are corrected by means of the Pigouvian tax within the tax-raising jurisdiction and on the other hand the respective tax revenue can be used for side-payments inducing other countries to further mitigate global environmental pollution.

We show that in a simultaneous move game with two countries both players will offer a take-it-or-leave-it contract that entails a side-payment which meets the individual rationality constraint of the opponent player in combination with the first-best optimal tax policy. The scheme does not require the coercive power of a central global authority but carbon taxes are implemented voluntarily by the individual countries.

From the perspective of implementation theory which has been mainly taken up in the study the take-it-or-leave-it contract can be understood as a simple method to illustrate the basic characteristics of an incentive-compatible transfer scheme which combats the spillover problem. Principally, we explore mechanisms

which are valid for a wide class of games of decentralized public good provision. Hence, apart from climate protection it may applicable for many different federal problems with interregional spillover effects.

Chapter 8

Conclusion

The basic objective of this study was to analyze the optimal design of interregional transfer schemes in federal systems, which are characterized by informational asymmetries, heterogenous technological shocks across regions, strategic competition for mobile resources and fiscal commons, modernization of public facilities, as well as interregional environmental spillover effects. Intrinsically, within a theoretical framework we model multistage Bayes-Nash games between a central government which offers a federal transfer programm and heterogenous local jurisdictions.

We demonstrated that local governments embedded in a federal setting do not act in isolation but interact with neighboring regions: typically local governments in federal states compete with one another for mobile resources and for grants from the common pool of federal funds. Thus, they are linked trough their treasuries and resource allocation, so that a policy change may have a considerable impact on neighboring jurisdictions. Moreover we pointed out that the central government who cannot observe local information types may nevertheless update its Bayesian beliefs if it anticipates interregional competition. Consequently, local policy becomes more accountable for the central government so that informational constraints can be relaxed.

For a more profound analysis of the underlying incentive problem we laid em-

phasis on the fact that the competition with specific variables may be based on different processes and mechanisms. For example tax competition cannot only be based on mobility of individuals, goods, factors or firms. Instead it can also be founded on local governments' entitlement to benefit from grants if a change of their tax policy makes local governments eligible for additional transfer. Indeed in *chapter 3* we showed that local government competing for mobile tax bases have a smaller scope of discretion for common pool fishing. In *chapter 6* we revisited this incentive problem analyzing the complexity of mobility based competition and competition for transfer if the central government intends to equalize tax base differences. In a full information setting, tax base equalizing grants entail a tax back effect that internalizes fiscal externalities and hence reconstitutes the *Rotten Kid Theorem*: the competition for addition transfers countervails the race-to-the-bottom. Expectedly rotten kids become again lazy if enforcement policies are unobserved by the central government. Here, we designed truthful second best optimal transfer mechanisms equalizing that makes use of the tax back effect by offering transfer with equalization rates different contingent on local types.

In *chapter 4* we analyze the ex-post redistribution problem based on the time-inconsistency of transfer schemes. Indeed, the central government' s incapacity to offer a well-defined transfer scheme ex-ante is often rooted in an asymmetric information structure predominant in the federal state. Here the main concern was to analyze the consequences of the ex-post redistribution problem from an information-based perspective. The local government's perspective to enlarge the latitude of discretion for local fiscal policy allowing them to draw higher informational rents from the common pool may provide considerable incentives for local precautionary investments. Although fully insured by a federal redis-

tribution mechanism, local governments are at least partly residual claimant of their own policy. This provides incentives for long-term projects reducing the likelihood of negative future shocks.

In the *chapter 5* we showed that local policy performance becomes meaningfully comparable for the central government by implementing a yardstick competition mechanism. We claim that transfer should depend at least partly on the policy measures and types of neighboring regions. Then the federal government can exploit the fact that self-interested jurisdictions do not internalize the informational externalities on neighboring jurisdictions when they pursue local policy measures. Likewise, local governments do not take into account that their policy measures serve as a signal for correlated types of neighboring jurisdictions. Therefore, the central government can learn more about local circumstances without offering information rents. In the second step we showed that the yardstick competition mechanism may provide positive incentives for local precautionary incentives with implications for the finding of the fourth chapter.

By suggesting a decentralized approach to raise environmental public good provision levels in *chapter 7* we take account of the lack of a coercive global authority that is able to enforce efficient international environmental regulations. In our model individual regions voluntarily commence international negotiations on public good provision, which are accompanied by side-payments. These side-payments are financed by means of regional externality-correcting taxes. Side-payments and national tax rates are designed in a mutually dependent way. The decentralized scheme we recommended for approaching Pareto efficient Nash equilibria is based on the ideas of Coasean negotiations and Pigouvian taxes.

Hence the frame of the model-theoretic analysis in this study widely differs

from the standard principle-agent theory, which mainly focuses on the relationship between a principal who delegates services to an agent. Furthermore we demonstrated that interregional redistribution is more complex than interpersonal redistribution: different to anonymous and independent households local governments are linked by their budgets, tax bases, resource alloction, and transboundary environmental effects.

In this study we briefly referred to some of the relevant empirical literature especially where empirical work can provide some evidence for the incentive problems based on informational asymmetries. Further it is hoped that the study at least impart some sense of the interplay of theory and applied policy. The aim was to characterize federal transfer scheme with allocative and redistributive objectives on theoretical grounds and to give instructions to reasonably contemplate reforms of federal transfer. Throughout the study we have already named some policy implications. Federal transfer programs typically play an important role in many federal states. In general a share of more than 5 per cent of the GDP is distributed in many federal states; see Costello (1993) Even though we can only derive small changes of transfer policies these may have an substantial impact on the federal economy. In the following we carry together a list of results which may apart from theorist be relevant for policy makers:

- Assignment of taxing powers:

  If local governments have the power to tax some mobile factors this might be welfare enhancing as we have learned. From the information-based perspective the optimal fiscal constitution of the federal state may assign the power to tax to local governments to advocate tax competition in an appropriate way and hence approximate the second best optimal solution.

- Assignment of spending powers:

It has becomes obvious that local governments which are highly dependent on federal aid may have a rather limited scope of discretion to choose local policy measures. Hence, despite of full insurance against negative shocks local governments may have incentives to invest in precautions long-term measures if good performance goes along with a better actionability of local governments in some policy fields. Due to policy reforms it should be put on record that an appropriate assignment of government functions to local authorities may alleviate the ex-post redistribution problem. Accordingly, we suggest a division of responsibilities which make local governments at least partly residual claimant of their policy.

- Transfers which depend on the policy measures of neighboring regions

  The central government should offer transfers which do not only depend on performance of a particular region but also on parameters of neighboring regions. In particular, the central government can filter out common technological shocks by an appropriate yardstick competition. Recently, in many federal states a better comparability of local public policy measure is coming up to discussion. For example the *Gemeindeprüfungsanstalt-GPA*, an agency for municipal audit of the Land North Rhine-Westphalia has introduced an index to evaluate public service innovation. The best practice program can be accompanied by a transfer scheme which makes correlated municipal policy more accountable.

- Tax base equalizing

  We have shown that the *Rotten Kid Theorem* can be recovered if local governments internalize the impact of their policy actions on neighboring regions. Recent literature has pointed out that Tax base equalizing programs

emerge to be relatively simple schemes in full information setting. Accordingly, this study conveyed that the second best optimal truthful transfer scheme can implementable by uncomplex tax base equalizing scheme with type-dependent equalization rates.

- Self-financing interregional environmental policy

  We proposed a mechanism in which side-payments are financed by the revenue raised by means of the eco-taxes. Thus, there exists a *double environmental dividend* of these eco-taxes. On the one hand global externalities are corrected by means of the Pigouvian tax within the tax-raising jurisdiction and on the other hand the respective tax revenue can be used for side-payments inducing other countries to further mitigate global environmental pollution.

Chapter 9

Appendix

9.1 Proof of Lemma 1

We prove for $n = 2$ that the tax rate t_i is an increasing function with respect to the technology parameter θ_i and hence high-ability jurisdictions raise higher taxes on capital. The first order conditions of the optimization problem can be expressed by a system of n equations:

$$\begin{bmatrix} F^1(\theta_1, \theta_2, t_1, t_2) \\ F^2(\theta_1, \theta_2, t_1, t_2) \end{bmatrix} = 0$$

We consider a change of value of the technology parameter θ_i by $d\theta_i$:

$$\begin{bmatrix} \frac{\partial F^1}{\partial t_1} & \frac{\partial F^1}{\partial t_2} \\ \frac{\partial F^2}{\partial t_1} & \frac{\partial F^2}{\partial t_2} \end{bmatrix} \begin{bmatrix} \frac{\partial t_1}{\partial \theta_1} \\ \frac{\partial t_2}{\partial \theta_1} \end{bmatrix} = \begin{bmatrix} \frac{-\partial F^1}{\partial \theta_1} \\ \frac{-\partial F^2}{\partial \theta_1} \end{bmatrix} \tag{9.1}$$

We can derive from the first order condition in equation (8) that the following applies:

$$\frac{\partial F^i}{\partial t_i} < 0 \quad \text{and} \quad \frac{\partial F^i}{\partial t_j} > 0 \tag{9.2}$$

$$\frac{\partial F^1}{\partial t_1} > -\frac{\partial F^1}{\partial t_2} \quad \text{and} \quad \frac{\partial F^2}{\partial t_2} > -\frac{\partial F^2}{\partial t_1} \tag{9.3}$$

$$\frac{\partial F^i}{\partial \theta_i} > \frac{\partial F^i}{\partial \theta_j} \geq 0 \tag{9.4}$$

It is worth mentioning that the derivatives from (9.2) to (9.4) all have a proper meaning: The first (9.2) signifies the concavity of the welfare function and the second term is the condition for strategically complementary tax policies among

jurisdictions; see Bulow et al. (1985). (9.3) tells us that there is a unique Nash equilibrium in the tax competition game (see Fudenburg and Tirole (1993)) and (9.4) is equivalent to the so-called sorting condition (see Guesnerie and Laffont (1984) and section 3 in this paper). Applying Cramer's rule for equation (9.1) therefore yields the following partial derivative:

$$\frac{\partial t_1}{\partial \theta_1} = \frac{1}{|J|} \quad \det \begin{bmatrix} \frac{-\partial F^1}{\partial \theta_1} & \frac{\partial F^1}{\partial t_2} \\ \frac{-\partial F^2}{\partial \theta_1} & \frac{\partial F^2}{\partial t_2} \end{bmatrix} > 0, \tag{9.5}$$

as $|J| = \left(\frac{\partial F^1}{\partial t_1}\frac{\partial F^2}{\partial t_2}\right) - \left(\frac{\partial F^1}{\partial t_2}\frac{\partial F^2}{\partial t_1}\right) > 0$ and $\left(\frac{-\partial F^1}{\partial \theta_1}\frac{\partial F^2}{\partial t_2}\right) - \left(\frac{\partial F^1}{\partial t_2}\frac{-\partial F^2}{\partial \theta_1}\right) > 0$ q.e.d.

9.2 Proof of Lemma 2:

Differentiating equation (9.13) with respect to θ_i yields

$$\frac{\partial b_i}{\partial \theta_i} = -\frac{1}{\theta_i}\left(b_i + \frac{\partial b_i}{\partial t_i}\frac{\partial t_i}{\partial \theta_i}\right)$$

Basically, there are two effects: Firstly there is a direct cost effect as the matching grant must be measured in proportion to the marginal rate of transformation (first term in parentheses). Secondly, there is an pecuniary effect as local governments raise different tax rates depending on the technology type θ_i, which is the latter term in parentheses. The sign of the latter term is indefinite as it depends on the balance of regional capital imports and exports. However, the absolute value of the pecuniary effect is relatively small as long as we consider federations with rising best response functions, so that $\frac{\partial b_i}{\partial \theta_i}$ has a negative value.

9.3 Proof of Theorem 1:

We show that total transfer payments are expressed by (3.16):

- The θ_L-jurisdictions have the most efficient provision technology and need the highest compensating grants. Therefore the constraint (3.14) which

assures U^0 for each jurisdiction should be binding for type $\theta_i = \theta_L$.

$$E_{\theta_{-i}}\left[V(z_i\{t_i(\theta_L), t_{-i}(\theta_{-i}), \theta_L\}) + x_i\{t_i(\theta_L), t(\theta_{-i})\} + s(\theta_L)|\theta_L\right] = U^0. \tag{9.6}$$

- Due to the direct mechanism jurisdictions announce a type which maximizes their local welfare, i.e. for which it applies:

$$\tilde{\theta}_i = \arg\max E_{\theta_{-i}}\left[V(x_i\{t_i(\theta_i), t(\theta_{-i})\}) + z_i\{t_i(\theta_i), t_{-i}(\theta_{-i}), s(\theta_i), \theta_i\}|\theta_i\right].$$

For truthful mechanisms it applies that $\tilde{\theta}_i = \theta_i$. Totally differentiating the incentive-compatibility constraint (3.15) yields

$$\frac{\partial U_i(t_i(\theta_i), t(\theta_{-i}), \theta_i)}{\partial \theta_i} = k_i(t_i(\theta_i), t_{-i}(\theta_{-i}))t_i(\theta_i). \tag{9.7}$$

Note that the envelope theorem implies that:

$$\frac{\partial U_i(t_i(\theta_i), t(\theta_{-i}), \theta_i)}{\partial \theta_i}\frac{dt_i(\theta_i)}{d\theta_i} = \frac{ds(\theta_i)}{d\theta_i}.$$

and that the sorting condition is fulfilled:

$$\frac{\partial}{\partial \theta_i}\left(\frac{\partial U_i/\partial t_i}{\partial U_i/\partial s_i}\right) > 0$$

- Integration of (9.7) yields the local welfare including transfer payments:

$$\begin{aligned} E_{\theta_{-i}}\left[V(f(k_i) - (r+t_i)k_i + r\bar{k}) + \theta_i\left(k_i t_i\right)|\theta_i\right] = \\ E_{\theta_{-i}}\left[U^0 + \int_{\theta_L}^{\theta_i} k_i t_i d\theta_i^0.\right] \end{aligned} \tag{9.8}$$

Note that the constant U^0 is determined by equation (9.6). Therefore we can determine the transfer scheme comprising a part to assure for utility U^0 in all jurisdictions and information rents to induce truth-telling:

$$\begin{aligned} s(\theta_i) = \frac{1}{\theta_i}E_{\theta_{-i}}[U^0 - V(f(k_i) - (r+t_i)k_i + r\bar{k}) + \theta_i\left(k_i t_i + s_i(\theta_i)\right) + \\ \int_{\theta_L}^{\theta_i} k_i t_i d\theta_i^0|\theta_i] \qquad \text{q.e.d.} \end{aligned} \tag{9.9}$$

9.4 Interior solution:

For small distortions the rent extraction effect always exceeds the welfare loss, so that there is an interior minimum. This is shown by the following argument: Let's assume that the efficient matching rate b_i is reduced by δb_i for types in the interval $[\theta_i, \theta_i + d\theta_i]$. Then local governments competing for mobile capital reduce their tax rates by $\frac{\partial t_i}{\partial b_i}\delta b_i$. That makes it less attractive to misrepresent types and gives rise to an expected reduction in the expected information rent by

$$\{(1 - P(\theta_i))(k_i + t_i \frac{\partial k_i}{\partial t_i})\} \frac{\delta t_i}{\delta b_i} d\theta_i. \tag{9.10}$$

The federal government expects jurisdictions to be of a type higher than θ_i with probability $1 - P(\theta_i)$. The expected loss in federal welfare, which goes along with a marginal reduction of the matching rate b_i is given by the following expression:

$$\begin{aligned} &\{\theta_i \left(k_i + \frac{\partial k_i}{\partial t_i} \right) + V_x(x_i) \left(\frac{\partial r}{\partial t_i}(\bar{k} - k_i) - k_i \right) + \\ &\sum_{j \neq i} \left(V_x(x_j) \frac{\partial r}{\partial t_i}(\bar{k} - k_j) + \left(\theta_j - \frac{1 - P(\theta_j)}{p(\theta_j)} \right) t_j \frac{\partial k_j}{\partial t_i} \right) \} \frac{\delta t_i}{\delta b_i} p(\theta_i) d\theta_i. \end{aligned} \tag{9.11}$$

By the first order condition (9.11) a marginal distortion away from the first best approximates zero while the rent extraction effect (9.10) is strictly positive.

9.5 Proof of Proposition 3

We show that a lower schedule of tax rates cannot provide higher incentives for a ling-term policy by contradiction. Consider two schedules of tax rates $\tilde{t}(\theta_i)$ and $\hat{t}(\theta_i)$, with $\tilde{t}(\theta_i) < \hat{t}(\theta_i)$ for all θ_i. Further we define the optimal investment policy $\tilde{y}$ $[\hat{y}]$ if local jurisdictions anticipate a schedule of tax rates $\tilde{y}(\theta_i)$ $[\hat{y}(\theta_i)]$. By the weak axiom of revealed preferences a local government anticipating a schedule of public good supply $\tilde{t}(\theta_i)$ $[\hat{t}(\theta_i)]$ cannot do better by choosing $\hat{y}$ $[\tilde{y}]$:

$$\int_{\theta_L}^{\theta_H} \theta_i \tilde{t}(\theta_i) k_1 P(\theta_i | \tilde{y}) d\theta_i + \gamma \tilde{y} \geq \int_{\theta_L}^{\theta_H} \theta_i \tilde{t}(\theta_i) k_1 P(\theta_i | \hat{y}) d\theta_i + \gamma \hat{y}, \tag{9.12}$$

$$\int_{\theta_L}^{\theta_H} \theta_i \hat{t}(\theta_i) k_2 P(\theta_i|\hat{y}) d\theta_i + \gamma\hat{y} \geq \int_{\theta_L}^{\theta_H} \theta_i \hat{t}(\theta_i) k_2 P(\theta_i|\tilde{d}) d\theta_i + \gamma\tilde{y}. \tag{9.13}$$

Adding up (9.12) and (9.13) yields

$$\int_{\theta_L}^{\theta_H} \theta_i (\hat{t}(\theta_i) - \tilde{t}(\theta_i))(P(\theta_i|\tilde{y}) - P(\theta_i|\hat{y})) d\theta_i \geq 0. \tag{9.14}$$

Suppose, for a moment that $\tilde{y} > \hat{y}$. But then $P(\theta_i|\hat{y})$ is higher than $P(\theta_i|\tilde{y})$ for all θ_i below 2 because of first order stochastic dominance. This however contradicts with the fact that equation (9.14) is positive or equal to zero. q.e.d.

9.6 Proof of Proposition 5

The lowest type is $\beta_i = 1$ which calls for the highest compensating grants. Therefore, the constraint (5.4) which assures U^0 for each jurisdiction should be binding for $\beta_i = 1$.

$$F(l) + \tau_i(1) - \frac{z_i(1)}{1} - y + V(z_i(1)) = U^0 \tag{9.15}$$

Due to the direct mechanism jurisdictions announce a type which maximizes their local welfare, i.e. for which

$$\tilde{\beta}_i = \arg\max F(l) + \tau(\tilde{\beta}_i) - \frac{z(\tilde{\beta}_i)}{\beta_i} - y + V(z(\tilde{\beta}_i)) \quad \text{applies.}$$

For a truthful mechanism it applies that $\tilde{\beta}_i = \beta_i$. Total differentiation of the incentive-constraint yields:

$$\frac{\partial U_i(z_i(\beta), \beta_i)}{\partial \beta_i} = \frac{z_i(\beta)}{\beta_i^2}. \tag{9.16}$$

Note that the envelope theorem implies that:

$$\frac{\partial U_i(z_i(\beta), \beta_i)}{\partial z_i(\beta)} \frac{dz_i(\beta)}{d\beta_i} + \frac{d\tau_i(\beta)}{d\beta_i} = 0$$

and that the sorting condition is fulfilled:

$$\frac{\partial}{\partial \beta_i} MRT_{xz}(\beta_i) > 0.$$

Integration of equation (9.16) yields the local welfare function including this payment:

$$F(l) + \tau_i(\beta) - \frac{z_i(\beta)}{\beta_i} - y + V(z_i(\beta)) = U^0 + \int_1^{\beta_i} \frac{z_i(b)}{b_i^2} db_i. \tag{9.17}$$

Therefore, we can write the transfer scheme comprising a redistributive part that concedes at least U^0 to all jurisdictions an incentives for truth-telling:

$$\tau_i(\beta) = U^0 - F(l) + \hat{y}_i + \frac{z_i(\beta)}{\beta_i} - V(z_i(\beta)) + \int_1^{\beta_i} \frac{z_i(\beta)}{b_i^2} db_i. \quad \text{q.e.d.} \tag{9.18}$$

9.7 Dominant strategy implementation

In the model the Bayesian allocation rule can be equivalently implemented in dominant strategies. In particular this means that the central government can offer a contract that implements the same local provision policy in dominant strategies and equally can afford the same welfare guarantee U^0 than with Bayesian implementation. As in equation (5.6) the constraint for a dominant strategy incentive compatible transfer scheme is

$$V(z_i(\beta)) - \frac{z_i(\beta)}{\beta_i} + \tau_i(\beta) - V(z(\tilde{\beta}_i)) + \frac{z(\tilde{\beta}_i)}{\beta_i} - \tau(\tilde{\beta}_i) \geq 0.$$

If the allocation rule is Bayesian incentive compatible the following inequality would be fulfilled

$$E_{\beta_{-i}} \left[V(z(\beta_i, \beta_{-i})) - \frac{z(\beta_i, \beta_{-i})}{\beta_i} + \tau(\beta_i, \beta_{-i}) - V(z(\beta_i, \tilde{\beta}_{-i})) + \frac{z(\beta_i, \tilde{\beta}_{-i})}{\beta_i} - \tau(\tilde{\beta}_i, \beta_{-i}) \right] \geq 0.$$

Formally, it can be shown that the scope for federal redistribution in the case with dominant strategy implementation

$$nE_{\beta_i|\hat{y}} \left[F(l) - \frac{z_i(\beta)}{\beta_i} - \hat{y}_i + V(z_i(\beta)) - \int_1^{\beta_i} \frac{z(b_i)}{b_i^2} db_i \right]$$

is equal to the Bayesian implementation case

$$E_{\beta_i|\hat{y}} \left[\sum_{i=1}^{n} E_{\beta_{-i}|\hat{y}} \left[F(l) - \frac{z_i(\beta)}{\beta_i} - \hat{y}_i + V(z_i(\beta)) - \int_1^{\beta_i} \frac{z(b_i)}{b_i^2} db_i \right] \right].$$

Mookherjee and Reichelstein (1991) pointed out three requirements for equivalent dominant strategy implementation of Bayesian allocation rules must be fulfilled: Firstly, the local welfare functions depend on the vector of local policy decision $\mathbf{z}$ only via a one-dimensional statistic $h_i : \mathbf{z} \to \Re$ and $D_i(\cdot, \beta_i) : \beta_i \times \Re \to \Re$ such that $U_i(z, \beta_i) = D_i(h_i(\mathbf{z}), \beta_i)$. Secondly, the single-crossing property must be fulfilled so that $\partial U_i/(\partial h_i \partial \beta_i) > 0$ and thirdly the monotonous hazard rate property. The one dimensional condensation property is fulfilled because local public good supply is financed via a non-distortive tax and there are no spill over effects. Moreover by assumption of the single crossing property and the monotonous hazard rate property hold. Therefore we can implement a local policy with dominant strategy incentive compatibility without a loss of welfare.

9.8 Proof of Proposition 7 and 9

We show that a lower schedule of public good provision cannot provide higher incentives for public good innovation by contraction. Consider two schedules of public good supply $z_1(\beta)$ and $z_2(\beta)$, where $z_1(\beta) < z_2(\beta)$ for all β. Further we define the optimal innovation policy y_1 $[y_2]$ if local jurisdictions anticipate a schedule of public good supply $z_1(\beta_i)$ $[z_2(\beta_i)]$. By the weak axiom of revealed preferences a local government anticipating a schedule of public good supply $z_1(\beta_i)$ $[z_2(\beta_i)]$ cannot do better by choosing y_2 $[y_1]$:

$$-\int_1^2 \frac{z_1(\beta_i)}{\beta_i^2} P(\beta_i|y_1)d\beta_i - y_1 \geq -\int_1^2 \frac{z_1(\beta_i)}{\beta_i^2} P(\beta_i|y_2)d\beta_i - y_2, \tag{9.19}$$

$$-\int_1^2 \frac{z_2(\beta_i)}{\beta_i^2} P(\beta_i|y_2)d\beta_i - y_2 \geq -\int_1^2 \frac{z_2(\beta_i)}{\beta_i^2} P(\beta_i|y_1)d\beta_i - y_1. \tag{9.20}$$

Adding up (18) and (19) yields

$$\int_1^2 \frac{z_2(\beta_i) - z_1(\beta_i)}{\beta_i^2} (P(\beta_i|y_1) - P(\beta_i|y_2))d\beta_i \geq 0. \tag{9.21}$$

Suppose, for a moment that $y_1 > y_2$. But then $P(\beta_i|y_2)$ is higher than $P(\beta_i|y_1)$ for all β_i below 2 because of first order stochastic dominance. This however

contradicts with the fact that equation (9.21) is positive or equal to zero. q.e.d.

9.9 Proof of Proposition 8

The schedule of public good supply is less distorted, if the central government knows the common factor $\xi = 1$. Comparing the hazard rates of the first order conditions (5.9), (5.12) and (5.13) respectively, it applies that

$$\frac{\int_{\beta_i}^{2} p(\beta_i)d\beta_i}{p(\beta_i)} = \frac{\int_{\beta_i}^{2} g(\beta_i - \frac{3}{2})d\beta_i}{g(\beta_i - \frac{3}{2})} > \frac{\int_{\beta_i}^{\frac{3}{2}} g(\beta_i - 1)d\beta_i}{g(\beta_i - 1)} \quad . \quad \text{q.e.d.}$$

Abbreviations

- For the sake of clarity, the underlying variables in the model-theoretic analysis are explained in each chapter. Hereafter I would like to specify abbreviations, which have not been named *in extenso*:

  LHS stands for **left-hand-side**

  RHS stands for **right-hand-side**

  s.t. stands for **subject to**

  CES stands for **constant return to scale**

  I-O stands for **Industrial Organization**

- In chapter 5 we signify the different stages of the game by t_1, ..., t_4. Expressing the timing of the game by t is conventional in literature. However in chapter 3, 4, and 6 the stages of the game are expressed by *stage 1*, ... ,*stage 4* in order to avoid any confusion with the tax rate on capital.

- As readers made themselves familiar with the strategic variable of the tax competition game t_i throughout chapters 3 and 4 we retain t_i as the strategic variable in chapter 6 as well: here t_i is defined as the *effective tax burden* contingent on the enforcement activities chosen by local tax authorities while in chapters 3 and 4 it signifies the *statutory tax rate*.

Acknowledgement

In preparing my dissertation I have accumulated a lengthy list of debts. First of all I would like to thank my doctoral advisor Professor Thomas Kuhn for many discussions and numerous suggestions of improvements of my dissertation. I appreciated to work with my co-authors Professor Thomas Kuhn, Professor Eytan Sheshinski, Dirk Rübbelke and Daniel Becker. I gained new insights in other research topics by doing research in a team. Under reserve of the decision of the doctoral thesis admission board I like to thank Professors Klaus Dieter John and Michael Rauscher who agreed to act as referees in the graduation process. Moreover I like to thank my colleagues at the faculty of economic science Michael Pickhardt, Omar Feraboli, Diana Sonntag, Sebastian Sturm as well as Marlies Frömel for their support. Further, I am indebted to Professors Ben Lockwood, Elchanan Ben-Porath, and Joseph Zeira, Viktor Vanberg, Robin Boadway, David Wildasin, Anke Kessler, Ivan Veselic, and Daniel Lenz for helpful comments on previous drafts. A part of the study has been presented on congresses of the IPPF, EEA, CEA, INFER, PET, as well as the National Tax Association. Thanks to the congress participants for their comments. I am grateful to Professors Wolfram Richter, Michael Rauscher, and Joseph Zeira for inviting me to research seminars in Dortmund, Rostock, and Jerusalem. My parents, my brother Daniel, Christine Ramphal, and my friends helped me in many other ways as well. My thanks to all. None of the above bears any responsibility for errors or omissions, however. Furthermore, I am grateful to the faculty and staff of the Department

of Economics of the Hebrew University of Jerusalem as well as the Center for the Study of Rationality, where I have spent one month as a visiting researcher. Last but not least financial support from the German Science Foundation (DFG) through SSP 1142 "Institutional Design of Federal Systems" is gratefully acknowledged.

References

Ahmad, E. and B. Searle (2008), On the implementation of transfers to Subnational Governments, in E. Ahmad and G. Brosio, (eds.) *Handbook of Fiscal Federalism*, pp. 381-404.

Altemeyer-Bartscher, M., D. Rübbelke, and E. Sheshinski (2007), Policies to Internalize Reciprocal International Spillovers. *CESifo working paper.*

Altemeyer-Bartscher, M., D. Rübbelke, and E. Sheshinski (2009), Environmental Protection and the Private Provision of International Public Goods. *Economica*, (In Press).

Altemeyer-Bartscher, M., and T. Kuhn (2009), On the Economics of Ex-Post Transfers in a Federal State. Working Paper.

Altemeyer-Bartscher, M., and T. Kuhn (2006a), Optimal Design of Federal Transfer- Schemes in the Presence of Tax Competition and Asymmetric Information, *Wirtschaftswissenschaftliche Diskussionspapiere TU Chemnitz 78/2006* (überarbeitete Version 2009).

Altemeyer-Bartscher, M., and T. Kuhn (2006b), Sustainable Urban Policy in Federal States with Grants-in-Aid, Mobile Tax Base, and Asymmetric Infor-

mation, *Wirtschaftswissenschaftliche Diskussionspapiere TU Chemnitz, 77/2006* (überarbeitete Version 2009).

Altemeyer-Bartscher, M. (2005), On Federal Redistribution and Optimal Incentives for Local Government Policies. Working Paper.

Althammer, W. and W. Buchholz (1993), Lindahl-equilibria as the Outcome of a Non-cooperative Game. *European Journal of Political Economy*, vol. 9, pp. 229-405.

Arrow, K.(1963), Uncertainty and the Welfare Economics of Medical Care. *American Economic Review*, vol. 53, pp. 91-96.

Barrett, S. (1992), Convention on Climate Change - Economic Aspects of Negotiations. *OECD*, Paris.

Barrett, S. (1995), The Strategy of Joint Implementation in the Framework Convention on Climate Change. UNCTAD/GID/10, United Nations, New York.

Baretti, C., B. Huber and K. Lichtblau (2002), A tax on tax revenue: the incentive effects of equalizing transfers: evidence from Germany. *International Tax and Public Finance* , vol. 9, pp. 631-649.

Becker, G. S. (1981), A Treatise on the Family, Cambridge, Mass. Harvard University Press.

Becker, G. (2005), The Becker-Posner Blog. Major Disasters and the Good Samaritan Problem. September, 4th 2005. http://www.becker-posner-blog.com

Bergstrom, T. (1989), A Fresh Look at the Rotten Kid Theorem – and other Household Mysteries. *Journal of Political Economy*, vol. 97(5), pp. 1138-1159.

Bergstrom, T., D. Rubinfeld and T. Shapiro (1983, p. 1188), Micro-based estimates of demand functions for local school expenditures, *Econometrica* 50, 1183-1205.

Besley, T. and A. Case (1995), Incumbent Behavior: Vote-Seeking, Tax-Setting, and Yardstick Competition. *American Economic Review*, vol. 85, pp 25-45.

Besley, T. and M. Smart (2002), Does Tax Competition Raise Voter Welfare?. *CEPR Discussion Papers:* 3131.

Besley, T. and S. Coate (2003), Centralized Versus Decentralized Provision of Local Public Goods: A Political Economy Approach. *Journal of Public Economics* 87, pp. 26112637.

Besley, T. and M. Smart (2003), Fiscal Restraints and Voter Welfare. *CEPR Discussion Papers:* 3131.

Boadway, R. (2008), Intergovernmental Redistributive Transfers: Efficiency

and Equity, in E. Ahmad and G. Brosio, (eds.) *Handbook of Fiscal Federalism*, pp. 355-380.

Boadway, R. (2004), The theory and practice of equalization. *CESifo Economic Studies*, pp. 211-254.

Boarnet, M. G. and A. Glazer (2002), Federal grants and yardstick competition. *Journal of Urban Economics*, vol. 52, pp. 53-64.

Bordignon, M., F. Cerniglia and F. Revelli (2003), In Search of Yardstick Competition: a spatial analysis of Italian municipality property tax setting. *Journal of Urban Economics*, 54: 2, pp. 199-217.

Bordignon, M., P. Manasse and G. Tabellini (2001), Optimal Regional Redistribution under Asymmetric Information. *American Economic Association*, 91:3, pp. 709-723.

Bordignon, M., P. Manasse and G. Tabellini (2001), Optimal Regional Redistribution under Asymmetric Information. *Center for Economic Policy Research Discussion Paper*, 1437.

Brennan, G. and J. Buchanan (1980), The Power to tax. *Analytical Foundations of a Fiscal Constitution*, Cambridge University Press.

Breton, A. (2008), Modelling Vertical Competition, in E. Ahmad and G. Brosio, (eds.) *Handbook of Fiscal Federalism*, pp. 86-105.

Buchanan, J. (1975), A Contractarian Paradigm for Applying Economic Theory, *American Economic Review*, vol. 65(2), pp. 225-30.

Buchholz, W. and Konrad, K.A. (1995), Strategic Transfers and Private Provision of Public Goods. *Journal of Public Economics*, Vol. 57, 489-505.

Bucovetsky, S. (1991), Asymmetric Tax Competition, *Journal of Urban Economics*, 30, pp. 167-181.

Bucovetsky, S., M. Marchand and P. Pestieau (1998), Tax Competition and Revelation of Preferences for Public Expenditure, *Journal of Urban Economics*, 44, pp. 367-390.

Bucovetsky, S. and M. Smart (2006), The Efficiency Consequences of Local Revenue Equalization: Tax Competition and Tax Distortions. *Journal of Public Economic Theory*, 8: 1, pp. 119144.

Bulow, J., J. Geanakoplos and P. Klemperer (1985), Multimarket Oligopoly. *Journal of Political Economy*, vol. 93:3, pp. 488511.

Büttner, T. (2006), The Incentive Effect of Fiscal Equalization Transfers on Tax Policy. *Journal of Public Economics* , 90:3, pp. 477-497.

Coase, R. (1960), The Problem of Social Cost. *Journal of Law and Economics*, Vol. 3, 1-44.

Cornes, R. and E. C. Silva (2002), Local Public Goods, Interregional Transfers and Private Information, *European Economic Review*, 46, pp. 329-56.

Cornes, R. and E. C. Silva (2003), Public Good Mix in a Federation with Incomplete Information. *Journal of Public Economic Theory*, 5: 2, pp. 381-97.

Costello, D. (1993), Intergovernmental grants: what role for the European Community? *European Economy*, No. 5.

Cremer, H. and F. Gahvari (2000), Tax Evasion, Fiscal Competition and Tax Coordination and Economic Integration, *European Economic Review*, 44, pp. 1633-1657.

Cremer, J., A. Estache and P. Seabright. (1996), Decentralizing Public Services: What Can We Learn from the Theory of The Firm? *Revue dEconomie Politique* 106, pp. 3760.

Dalby, B. (1996), Fiscal Externalities and the Design of Intergovernmental Grants. *International Tax and Public Finance*, vol. 3, pp. 297-412.

Dafflon, B. (2008), The Assignment of Functions to Decentralized Government: from Theory to Practice, in E. Ahmad and G. Brosio, (eds.) *Handbook of Fiscal Federalism*, pp. 271-305.

Dalen, D. M. (1998), Yardstick Competition and Investment Incentives. *Jour-*

nal of Economics and Management Strategy, 7: 1, pp. 105-126.

Danziger, L. and Schnytzer, A. (1991), Implementing the Lindahl Voluntary-exchange Mechanism. *European Journal of Political Economy*, Vol. 7, 55-64.

DePater, J. and M. Myers (1993), Strategic Capital Competition: A Pecuniary Externality and Corrective Device, *Journal of Urban Economics*, 36, pp. 66-78.

Edwards, J. and M. Keen,(1996), Tax competition and Leviathan. *European Economic Review*, vol. 40(1), pp. 113-134.

Falk, I. and R. Mendelsohn (1993), The economics of controlling stock pollutants: Am efficient strategy for greenhouse gases. *Journal of Environmental Economics and Management*, vol. 25, pp. 76-88.

Falkinger, J. F. Hackl and G.J. Pruckner (1996), A Fair Mechanism of Efficient Reduction of CO2-emmisions. *Finanzarchiv*, Vol. 53, 308-311.

Fehr, H. (2001), Fiskalische und allokative Konsequenzen des neuen Länderfinanzausgleichs. *Wirtschaftsdienst*, 10/2001, pp. 573-580.

Fudenberg, D. and J. Tirole (1991), Game Theory. *The MIT Press*, Cambridge, MA,.

Gale, D. and Hellwig, M. (1989), Repudiation and Renegotiation: The Case

of Sovereign Debt. *International Economic Review*, vol. 30(1), pp. 3-31.

Gersbach, H. and R. Winkler (2007), On the Design of Global Refunding and Climate Change. ETHZ - economic working paper, no. 07-69.

Gibbard, A. (1973), Manipulation of Voting Schemes: A General Result. *Econometrica* 41, pp. 587-601.

Gleaser, E. L. (2005), Should the Government Rebuild New Orleans, Or Just Give Residents Checks?. *The Economists' Voice*, v. 2:4, art. 4.

Goodspeed, T. (2002), Bailouts in a Federation. *International Tax and Public Finance*, vol. 9(4), pp. 409-421.

Goodspeed, T. and A. Haughwout, (2006), On the Optimal Design of Disaster Insurance in a Federation. *Working Papers* 2006-14, University of Kentucky, Institute for Federalism and Intergovernmental Relations.

Gramlich, E. (1968), Alternative federal policies for stimulating state and local expenditures: a comparison of their effects. *National tax journal*, vol. 21 (2), pp. 119-129.

Green, J. and Sheshinski, E. (1976), Direct versus Indirect Remedies for Externalities. *Journal of Political Economy*, Vol. 84, 797-808.

Green, J. and J.-J. Laffont (1977), Characterization of Satisfactory Mech-

anism for the Revelation of Preferences for Public Goods. *Econometrica* 45, pp. 427-438.

Guesnerie, R. and J.-J. Laffont (1984), A complete solution to a class of principal-agent problems with an application to the control of a self-managed firm. *Journal of Public Economics*, 25, pp. 329-369.

Guttman, J.M. (1978), Understanding Collective Action: Matching Behavior. *The American Economic Review*, Vol. 68, 251-255.

Guttman, J.M. (1987), A Non-Cournot Model of Voluntary Collective Action. *Economica*, Vol. 54, 1-19.

Guttman, J.M. and Schnytzer, A. (1992), A solution of the Externality Problem Using Strategic Matching. *Journal of Economic Behaviour and Organization*, Vol. 4, 249-264.

Hayek, F. A. (1945), The Use of Knowledge in Society. *American Economic Review*, 35, pp. 519-530.

Huber, B. and M. Runkel (2006), Optimal Design of Intergovernmental Grants Under Asymmetric Information. *International Tax and Public Finance*, 13, 25-41.

Huber, B. and M. Runkel (2003), Optimal Design of Intergovernmental Grants Under Asymmetric Information. *Ces Ifo Working Paper*, No. 919.

INMAN, R. P. (2003), Transfers and Bailouts: Enforcing Local Fiscal Discipline with Lessons from U.S. Federalism, in J. Rodden et al.(eds.), *Fiscal Decentralization and the Challenge of Hard Budget Constraints.* Cambridge, MA: MIT Press, pp. 3583.

IPCC (1998), The Regional Impacts of Climate Change - An Assessment of Vulnerability. Cambridge University Press, Cambridge et al.

ITOH, A. and TAWADA, M. (2003), Environment, Trade and the Welfare Gains from the Transfer of Pollution Abatement Technology. *Papers in Regional Science*, Vol. 82, 519-534.

JOHN, K. and T. RÜBBELKE (2007), Poverty Eradication and Environmental Protection. in John, K. and T. Rübbelke, (eds.) *Development Aid and Environmental Protection*, Peter Lang Verlag.

KAISER, K. (2008), Restricted Bailouts and the Commitment Problem in Federations. *BGPE Discussion Paper* No 62.

KNEEN, M. and M. MARCHAND (1997), Fiscal competition and the pattern of public spending, *Journal of Public Economics*, 66.

KORNAI, J., E. MASKIN and G. ROLAND (2003), Understanding the Soft Budget Constraint. *Journal of Economic Literature*, American Economic Association, vol. 41(4), pp. 1095-1136.

KÖTHENBÜRGER, M. (2007), Ex-post redistribution in a federation: Implications for corrective policy. *Journal of Public Economics*, vol. 91(3-4), pp. 481-496.

KÖTHENBÜRGER, M.(2002) Tax Competition and Fiscal Equalization. *International Tax and Public Finance*, 9: 4, pp. 391-408.

KOTSOGIANNIS, C. and R. SCHWAGER, (2006), On the incentives to experiment in federations. *Journal of Urban Economics*, vol. 60(3), pp. 484-497.

KUHN, T. (1991), Zuweisungen und Allokation im Kommunalen Finanzausgleich. *Finanzarchiv*, vol. 49(2). pp. 215-236.

KUHN, T. (1995), Theorie des Kommunalen Finanzausgleichs - Allokative und distributive Aspekte, *Wirtschaftswissenschaftliche Beiträge* , vol. 109, Physika, Heidelberg.

LAFFONT, J.-J. and J. TIROLE (1993), A Theory of Incentives in Procurement and Regulation. *MIT*.

LAUSSEL, D. and M. LE BRETON (1998), *Regional Science and Urban Economics*, vol. 28:3, pp. 283-296.

LINDBECK, A. and J. WEIBULL (1988), Altruism and Time Inconsistency: the Economics of Fait Accompli. *Journal of Political Economy*, vol. 96, pp.

1165-86.

Lenk, T., H. Fuge and F. Schneider (1998), Zurück zu mehr Föderalismus. *Economics Working Paper* 9805, University of Linz.

Lockwood, B. (1999), Interregional Insurance, *Journal of Public Economics*, 72, pp. 1-37.

Lockwood, B. (2008), The Political Economy of Decentralization, in E. Ahmad and G. Brosio, (eds.) *Handbook of Fiscal Federalism*, pp. 33-61.

Mirrlees, J. (1971), An Exploration in the Theory of Optimum Income Taxation, *Review of Economic Studies*, vol. 38, pp. 175-208.

Myerson, R. (1979), Incentive-Compatibility and the Bargaining Problem. *Econometrica*, 47, pp. 61-73.

Nordhaus, W.D. (2006), After Kyoto: Alternative Mechanisms to Control Global Warming. *The American Economic Review*, Vol. 96, 31-34.

Oates, W. E. (2005), Toward a Second-Generation Theory of Fiscal Federalism, *International Tax an Public Finance*, 12:4, pp. 349-373.

Oates, W. E., and R. M. Schwab (1988), Economic Competition among Jurisdictions: Efficiency-Enhancing or Distortion-Inducing?. *Journal of Public Economics* 35, pp. 333-54.

Oates, W. E. (1972), Fiscal Federalism, Harcourt Brace Jovanovich, New York.

OECD (2006), Survey of Germany. *OECD Economic Surveys*, no. 8.

Peralta, S. and T. van Ypersele (2002), Capital Tax Competition among an Arbitrary Number of Asymmetric Countries. *CORE Discussion Paper*.

Persson, T. and G. Tabellini (1996), Federal Fiscal Constitution: Risk Sharing and Moral Hazard. *Econometrica*, 64, pp. 923-646.

Pigou, A.C. (1932), The Economics of Welfare. *Macmillan* (London).

Prudhomme, R. (1995), The Dangers of Decentralization. *World Bank Research Observer*, vol. 10, pp. 20120.

Raff, H. and J. Wilson, (1997), Income Redistribution with Well-Informed Local Governments. *International Tax and Public Finance*, vol. 4(4), pp 407-427.

Rauscher, M. (1998), Leviathan and Competition among Jurisdictions: The Case of Benefit Taxation. *Journal of Urban Economics*, vol. 44(1), pp 59-67.

Rauscher, M. (1994), On Ecological Dumping. *Oxford Economic Paper*, 46, pp. 820-840.

Reichelstein, S. (1992), Constructing Incentive Schemes for Government Con-

tracts: An Application of Agency Theory. *The Accounting Review*, vol. 67:4, pp. 712-731.

Revelli, F. (2008), Special Interactions among Governments, in E. Ahmad and G. Brosio, (eds.) *Handbook of Fiscal Federalism*, pp. 106-131.

Rodden, J. (2001), And the Last Shall be the First: Federalism and Fiscal Outcomes in Germany. *mimeo,* Harvard University, Cambridge, CA.

Rübbelke, D.T.G. and Sheshinski, E. (2005), Transfers as a Means to Combat European Spillovers. *Jahrbücher für Nationalökonomie und Statistik*, Vol. 225, 699-710.

Sächsischer Landtag (2003), Gesetz zur Änderung von Gesetzen des kommunalen Finanzausgleichs. *Drucksache* 3/9366.

Salmon, P. (2008), Horizontal Competition among Governments, in E. Ahmad and G. Brosio, (eds.) *Handbook of Fiscal Federalism*, pp. 61-85.

Schelling, T.C. (1992), Some Economics of Global Warming. *The American Economic Review*, Vol. 82, 1-14.

Schelling, T.C. (1995), Intergenerational Discounting. *Energy Policy*, Vol. 23, 395-401.

Seitz, H. and G. Kempkes (2006), Infrastruktur und regionale Wirtschaftsen-

twicklung, in: Broecker, J., M. Fritsch und M. Junkernheinrich (eds.) *Ökonomische Geografie - Eine Einführung*, Verlag Franz Vahlen.

Sheshinski, E. (2004), On Atmosphere Externality and Corrective Taxes. *Journal of Public Economics*, Vol. 88, 727-734.

Smart, M. (1998), Taxation and Deadweight Loss in a System of Intergovernmental Transfers. *Canadian Journal of Economics*, vol. 31(1), pp. 189-206.

Stiglitz, J. E. (1982), Self-selection and Pareto efficient taxation. *Journal of Public Economics*, vol. 17(2), pp. 213-240.

Stöwhase, S. and C. Traxler (2005), Tax Evasion and Auditing in a Federal Economy. *International Tax and Public Finance*. vol. 12: 4, pp. 515-532.

Wellisch, D. (2000), Theory of Public Finance in a Federal State. *Cambridge University Press*.

Wildasin, D. (1997), Externalities and bailouts : hard and soft budget constraints in intergovernmental fiscal relations. *Policy Research Working Paper Series* 1843, The World Bank.

Wildasin, D. (1989), Interjurisdictional Capital mobility: Fiscal Externality and a Corrective Subsidy. *Journal of Urban Economics*, 25, pp. 193-212.

Wildasin, D. (2006), Disasters: Issues for State and Federal Government Fi-

nances, Working Papers 2006-07, University of Kentucky, Institute for Federalism and Intergovernmental Relations.

WILDASIN, D. (2009), State and Local Government Finance in the Current Crisis: Time for Emergency Federal Relief?, Working Papers 2009-07, University of Kentucky, Institute for Federalism and Intergovernmental Relations.

WILSON, J.D. (1986), A Theory of Interregional Tax Competition. *Journal of Urban Economics*, 19: 3, pp. 296-315.

WILSON, J.D. (1999), Theories of tax competition. *National Tax Journal*, vol. 52:2, pp. 269-302.

WILSON, J. D. (2008), Tax Competition in a Federal Setting, in E. Ahmad and G. Brosio, (eds.) *Handbook of Fiscal Federalism*, pp. 339-354.

WILSON, J. D. and E. Janeba (2008), Decentralization and International Tax Competition, Journal of Public Economics, Vol. 89, pp. 1211-29.

WURZEL (1999), Towards more Efficient Governments: Reforming Federal Fiscal Relations in Germany. *OECD Economics Department Working Papers* no. 209.

WURZEL, E. (1998), Towards more Efficient Government: Reforming Federal Fiscal Relations in Germany Economics. *OECD - Department Working Papers* No. 209.

Zodrow, G. R. and P. Mieszkowski (1986), The new view of property tax: A reformulation. *Regional Science and Urban Economics*, 16, pp. 309-27.