On the Economics of Ex-Post Transfers in a Federal State: A Mechanism Design Approach

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Abstract

In this paper we show that central governments cannot offer grants *ex ante* in a federal states with informational asymmetries as well as inter-temporal commitment problems. We analyze incentives for local governments to supply public goods if the central government offers grants-in-aid *ex post* and investigate in which way the timing of transfer payments play a role for allocative and redistributive efficiency. We show that local governments' incentives to provide public goods are distorted if they rely on federal grants-in-aid offered ex post. Furthermore it becomes obvious that local governments are apt to substitute tax revenue for higher grants-in-aid if relevant local data are private information. Local governments can mispresent or hide these data in order to justify policy shortfalls in the region. To which extend ex post transfers mitigate local governments' incentives crucially depends on the information structure predominant in the federation.

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1 Introduction

In many federal states such as Canada, Germany, and Switzerland the central government pays transfers towards local jurisdictions. Oates (1972, 2005) points out two key mandates of federal grants: On the one hand the center intends to correct external effects from inter-regional spill overs as well as from tax competition. On the other hand fiscal disparities across jurisdictions should be equalized. Inter alia Wilson (1986), and Wildasin (1989) show that in an ideal federation with complete information and no restriction on instruments the first best optimal policy can be implemented by lump-sum payments and matching grants, which equalize disparities and correct for external effects, respectively. Concretely, if the central government pays grants *before* any local decision is taken it can make jurisdictions residual claimants of local policy: local governments are fully insured provided that they pursue an optimal region-specific policy.

Nevertheless, local governments in many federal states receive grants *ex-post*, i.e. after they have provided local public goods, see e.g. Köthenbürger (2007). Intrinsically, there are two reasons for why a central government pays ex-post grants. Firstly, the central government cannot tailor transfers to a regions-specific situation because of informational asymmetries. In this case it must offer grants contingent on observable local policy measures chosen by the local governments. Secondly, local governments have to take long-term decisions with an inter-temporal horizon, like investments in local infrastructure or modernization of local public services. In this connection the central government cannot inter-temporally commit to specific transfer rules.

We investigate in which way the timing of transfer payments plays a role for allocative and redistributive efficiency in an environment with asymmetric information. We show that local governments relying on ex post transfers postpone costly long-term projects into the future and risk high consequential costs. Furthermore it becomes obvious that local governments are apt to substitute tax revenue for higher grants-in-aid if relevant local data are unobservable for the central government. Local governments can misprepresent or hide these data in order to justify poor situations in the region. We analyze to which extend ex post transfers mitigate local governments incentives to provide public goods and point out the interrelation between short-term policy and long-term projects chosen by local governments.

In particular, we consider a federal state consisting of a central government and several local jurisdiction. Local public goods are decentrally provided by local government. Thereby local decision-makers have to choose two types of local policy measures: Firstly, local governments pursue a long-term policy like investment in infrastructure and modernization of public services, which may positively effect the efficiency and the well-being of the region in future periods. Secondly, local governments expend public funds for short-term public consumption. Hence, local governments face a typical investment problem trading off between a high public consumption today and high investments in order to be prepared for future periods.

Local public good provision is financed by federal grants-in-aid as well as a source based tax on mobile capital. Employing a capital tax local governments are concerned about the outflow of capital and mobil firms if the local tax burden is too high. As a result they choose inefficiently low tax rates with twofold consequences in a dynamic context: Besides an under-provision of public goods as the main focus in the literature local governments may try to postpone costly long-term projects into the future. Wilson (1986), and Wildasin (1989) have shown that the central government can restate an efficient allocation of resources and fully equalize disparities by offering a system of *ex ante* transfers.

Notwithstanding, federal grants can be a source of inefficiency themselves if they are payed ex post. As federal is aid guaranteed by constitutional law the central government cannot inter-temporally commit to punish those local governments which have pursued an unsound policy in the past. Hence, in a regime of fiscal equalization local governments anticipate that they won't have to take the whole burden of past policy shortfalls. This phenomenon is related to the literature in the *Good Samaritan Problem*, see Buchanan (1975). Relying on equalizing grants local governments are willing to take the risk of high future costs resulting from a poor long-term policy. Wurzel (1998) who analyzes the case of German fiscal relations notes that local governments underestimate consequential costs of an poor maintenance of public facilities. He points out that the side effects of investment shortfalls are not fully reflected in the local governments' budget, if disparities are equalized ex post. Refereing to the rebuilding of New Orleans after the hurricane Katrina Becker (2006), Glaeser (2006) and Goodspeed (2007) point out that local governments' decisions would be optimal if they would have to bear fully the social cost of their respective policy in the case of an natural disasters. In a frame with strategic tax competition local governments tend to shift the burden of long-term investments onto the federation as a whole to enable tax dumping.

While the central government can hardly inter-temporally commit to a transfer rule in order to provide optimal incentives for long-term projects it may be able to determine ex ante transfer payments within a budget period before local short-policy measures are accomplished. However a second limitation on the applicability of ex ante grants is the information needed by the central government to tailor transfers to region-specific circumstances. As can be observed in practice local governments may be able to better estimate the region-specific costs than the central government, see Oates (2005), Cornes and Silva (2002). Hence, the federal government cannot ex ante commit to offer transfer schemes being contingent on local types.

It can only offer transfer payments ex post contingent on observable transfer payments. Local governments may then find it preferable to misrepresent information types to be eligible to a higher matching rate. This phenomenon generates a problem of adverse selection. Normally, transfer payments offered by the central government must be tailored to the specifics of local environmental cost functions. Yet, local productivity is widely understated by local governments to induce higher grants-in-aid which then can compensate for a lower tax effort. In this paper we show that the scope for federal redistribution as well as for co-funding is limited by informational constraints.

By the revelation principle, we do restrict our search for the optimal transfer scheme to truthful direct revelation mechanisms. The central government must offer some positive information rents to local jurisdictions, so that truthful revelation of fiscal needs for public good supply by all local governments is a perfect Bayesian equilibrium. We show that the central government can offer more progressive transfer schemes if less high-powered incentives are provided for local tax effort. Therefore, it turns out in the paper that it is not optimal to fully internalize external effects of tax competition in the second best optimum.

Finally, to which extend incentives for local governments are undermined by federal aid will crucially depend on the progressivity of the transfer scheme. Information rents imply a less progressive transfer scheme and alleviate the Good Samaritan Problem. If the progressivity is reduced to provide tax incentives, local governments partly become residual claimants of local policy. From this viewpoint long-term policy can be considered as an investment in higher expected information rents.

Recently some papers in the fiscal federalism have investigated the incentive problems of decentralized authorities in an incomplete information environment. Bucovetsky, Marchand and Pestieau (1998), Lockwood (1999), Bordignon, Manasse, and Tabellini (2001) and Altemeyer-Bartscher and Kuhn (2007) have investigated the optimal design of federal transfers that overcome adverse selection problems. However in these models a federal transfer policy is an one-shot game so that these papers abstract from agency problems following from dynamic decision making. Another strand of literature analyze the bail-out problem in federal states. Wildasin (1997), Bordignon (1997) and Goodspeed (2002) show that soft budget constraints provide incentives for inefficient borrowing. The bail out literature focuses on the problem of fiscally irresponsible policy whereas we describe fiscal equalizing that reduces disparities in every period.

2 Model and Problem

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 $i = \{1, 2, ..., n\}$. The central government offers a transfer scheme towards the local level with a redistributive and corrective function. We distinguish between two types of policy measures: a long-term policy y_i and a short-term policy z_i. The short-term policy can be be interpreted as a expenditures for public consumption with a one period horizon. In contrary, the long-term policy entails investments and modernization, which an positive impact on efficiency and wellbeing of the region in the future.

For simplicity costs of long-term investments y_i is normalized to one for all i, while the supply of z_i entails cost which may differ across regions. We define the marginal rate of transformation between private good consumption x_i and the supply of z_i by $MRT^i_{xz} = \theta_i$, which may vary in i. The elements of the profile of the jurisdictions' technological types $\theta = \{\theta_1, \theta_2, ..., \theta_n\} = \{\theta_i, \theta_{-i}\}$ are independently drawn from a commonly known joint distribution on $\times_{i=1}^{n}[\theta_L, \theta_H]$ with $\theta_H > \theta_L > 1$, a cumulative distribution function $P(\theta_i|y_i)$, a density function $p(\theta_i|y_i) > 0$ on $[\theta_L, \theta_H]$ and $\theta_L > p(\theta_L|y_i)$.

Investments in infrastructure and modernization of public services increases efficiency of the region and reduces expected costs of public good provision z_i, 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.

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. The production technology exhibits constant returns to scale and is described by a homogeneous production function. The output expressed in intensive-form is $f(k_i)$, with $f_k(k_i) > 0$, $f_{kk}(k_i) < 0$, when k_i units of capital and one unit of labor are employed. Local jurisdictions finance the provision of local public goods via a unit tax on capital, denoted by t_i, in addition to transfer payments s_i received by the federal government. We can define the local governments' budget constraint as:

$$t_i k_i + s_i = z_i/\theta_i + y_i,$$

where s_i is a federal transfer received by jurisdiction i.

Factor markets are taken perfectly competitive and the production factors are therefore valued at their marginal productivity:

$$f_k(k_i) = r + t_i \qquad \text{and} \tag{1}$$

$$f(k_i) - k_i f_k(k_i) = w_i, \tag{2}$$

where $r + t_i$ gives the user cost of capital and w_i is the price for the fixed factor in region i. The factor demand is $f_k(r+t_i)^{-1} \equiv k_i(r+t_i)$ with $k_i'(r+t_i) = \frac{1}{f_{kk}(k_i)}$. As capital is mobile within the borders of the federation factor prices adjust to clear markets at the Walrasian equilibrium. Therefore, a change in the unit tax on capital t_i implies a decline of the net return of capital by

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

[1]As the federal capital stock is exogenously given and the capital market is cleared it applies that

Furthermore, some capital flows out of jurisdiction i and is employed in other regions:

$$\frac{\partial k_i}{\partial t_i} = \frac{1}{f_{kk}(k_i)}\left(1+\frac{\partial r}{\partial t_i}\right) < 0 \qquad \text{and} \qquad \frac{\partial k_j}{\partial t_i} = \frac{1}{f_{kk}(k_j)}\frac{\partial r}{\partial t_i} > 0. \tag{4}$$

The representative households' total income is composed of wage income and capital income. Representative households spend the whole net income for private good consumption x_i, which is defined by

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

Thereby, we assume that households in each region own an equal share of capital $\frac{\bar{K}}{n} = \bar{k}$. Local jurisdictions are *regionally benevolent* and can choose the capital tax rate as well as the mix of public goods 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

$$U_i \equiv U_i(x_i, y_i, z_i) = z_i + \gamma y_i + V_i(x_i), \tag{5}$$

where the parameter γ with $0 < \gamma < 1$ denotes the valuation of the y_i by local households.

2.2 The central governments' policy

The central government's objective is to reduce fiscal disparities among jurisdictions, which are caused by heterogenous costs of local public good provision. Therefore a minimum welfare level in *each jurisdiction* denoted by U^0 is to be guaranteed. We assume that local governments intend to minimize funds affordable to fulfill the insurance

$\frac{d\bar{K}}{dt_i} = 0$ 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 $\frac{\partial r}{\partial t_i} \geq -1$.

constraint. Therefore it offers a system of grants that provide optimal incentives for local tax policies t_i.

We can state the following minimization problem:

$$\min_{t_1,\ldots,t_n,s_1,\ldots,s_n} \sum_{i=1}^{n} E_{\theta_i}\left[s_i(\theta_i)\right] \tag{6}$$

$$\text{s.t.} \quad \theta_i\left(k_i t_i + s_i - y_i\right) + \gamma y_i + V_i(x_i) \geq U^0, \quad \text{for all } i. \tag{7}$$

Equations (7) define the welfare guarantee. The central government minimizes the expected value of total transfer payments. This assumption 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 converges to the effective payments in federations with a large number of jurisdictions.

The optimal design as well as the timing of the transfer mechanism will crucially depend on the information structure, in particular on wether θ_i is common knowledge or non- observable to the central government.

2.3 The timing of the game

The timing of the game is as follows:

- At *stage 0* a minimum welfare level U^0 is guaranteed by constitutional law.
- At *stage 1* local governments rely on the minimum welfare level which is warranted by constitutional law and decide on the amount of y_i.
- At *stage 2* nature draws a cost type θ_i for clean public good provision from a commonly known distribution. The distribution of types crucially depends on policy y_i taken at *stage 1.* Local governments can then observe their types.

- At *stage 3* the federal government offers a transfer scheme to guarantee a minimum welfare level U^0. The design of the transfer scheme depends on whether the central government can always observe the cost type θ_i or not.

- At *stage 4* local governments observe the federal transfer scheme and pursue a *regionally benevolent* tax policy t_i. In the tax competition game they face the outflow of mobile capital when it is taxed too much.

- At *stage 5* local jurisdictions receive the grants-in-aid ex post.

3 Some Benchmark Solutions: Laissez-Faire Local Policy and Ex Ante Transfers

In this section we examine local governments' incentives to pursue a mix of long-term and short-term policies in a federation without central government intervention. It becomes obvious that the central governments can restate efficiency in a federation with heterogenous jurisdictions and inter-regional spill over effects by offering externality correcting grants as well as equalizing grant *ex ante*.

3.1 Tax incentives

By backward induction we firstly consider local governments' tax policy at *stage 4*. After policy y_i has been chosen and nature has drawn the cost types local jurisdictions compete for mobile capital, which 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 $S_i = t_i \epsilon \Re_+$ is the set of tax policies of jurisdiction i. Assuming Nash strategies jurisdiction i pursues a local welfare maximizing tax policy t_i, given the tax policies of its neighbors t_{-i}. We define the best response function of i given its specific technology:

$$BR_i(t_{-i}) = \arg\max_{t_i} \quad z_i + \gamma y_i + V_i(x_i),$$

which entails the following first order condition:

$$\theta_i \left(k_i + t_i \frac{\partial k_i}{\partial t_i} \right) + V_x(x_i) \left(\frac{\partial r}{\partial t_i} \left(\bar{k} - k_i \right) - k_i \right) = 0 \quad \text{for all } i \tag{8}$$

Concavity of local welfare functions assures that the best response functions are single-valued and n equations with n unknowns yield a unique Nash equilibrium. Self-interested jurisdictions only recognize fiscal effects that impact its own welfare. In particular, it ignores the positive fiscal effects on neighboring jurisdictions and raises inefficiently low tax rates.

Comparing the decentralized solution (8) with the first best optimal solution it becomes obvious that local public goods are under-provided. Maximizing the federations' total welfare

$$\sum_{i=1}^{n} \{V(x_i) + \gamma y_i + z_i\}$$

we can decompose the marginal external effects of tax competition, which are not taken into account by local policy-makers:

$$\sum_{j \neq i} \left(V_x(x_j) \frac{\partial r}{\partial t_i} (\bar{k} - k_j) + \theta_j t_j \frac{\partial k_j}{\partial t_i} \right). \tag{9}$$

In line with the standard literature allocative efficiency is reestablished if the central government offers ex ante an externality correcting transfer with a matching rate set equal to the marginal external effect (9).

3.2 Incentives for Long-Term Policy

At *stage 1* local governments maximize the *conditional expected value* of local welfare and choose the following long-term policy:

$$\max_{y_i} E_{\theta_i}[V(x_i) + \gamma y_i + z_i | y_i].$$

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

$$1 = \gamma + \int_{\theta_L}^{\theta_H} \tilde{t}_i k_i P_{y_i}(\theta_i | y_i) d\theta_i \quad \text{for all } i, \tag{10}$$

where $\tilde{t}_i$ is the equilibrium tax rate of jurisdiction i played in the tax competition game at *stage 4*. The left hand side of equation (10) signifies the marginal cost of the long-term policy. The right hand side denotes the expected marginal cost of the short term policy z_i. With a well prepared infrastructure expressed by a high amount of y_i the cost of public good supply is expected to be low.

If local governments expect a small public sector in the future, they will invest less for policy y_i. For example long-term investments in infrastructure and public service modernization suppose that local governments will run these facilities in the future. If local governments anticipate at *stage 1*, that they will engage in tax competition with neighboring regions they tend to hazard the consequences of a dirty policy. In particular, if the marginal costs of public funding are high local governments substitute sustainable policy for a less costly dirty alternative. Thus, local governments reduce investments because they anticipate that they will engage in tax competition at *stage 4*.

Proposition 1 *More high-powered tax incentives go along with a higher provision of short-term public consumption and higher investments.*

Proof see Appendix

The first best optimal long-term policy can be implemented, if the central government can credibly pre-commit to a transfer rule that punishes local governments which choose an unsound long-term policy as well as fully corrects external fiscal effects . In the following section we will discuss to which extend a central government can provide optimal incentives for local policy by offering an incentive-compatible transfer scheme in a federation with asymmetric information and incomplete commitment devices.

4 Ex Post Transfer Schemes

In this section we therefore investigate the optimal federal transfer policy. As said, local governments may better estimate region specific cost types than the central government because of their close relation to on-site problems. Hence, we assume that the central government neither can observe the technology type θ_i nor the mix of public goods y_i and z_i locally supplied.

First of all, local governments decide on policy y_i at *stage 1*. Thereby local governments anticipate federal aid guaranteed by constitution law at *stage 0*. After the federal government has offered the transfer scheme at *stage 3* local governments compete for mobile capital and get involved into the tax competition game at *stage 4*.

4.1 General Problem

The central government, which is ignorant of local jurisdictions' types must rely on reports given by the local governments about their specifics. Local governments strategically mispresent or hide relevant data in order to substitute tax revenue for higher transfer payments. They can take advantage of mispresenting types in two respects. On the one hand, this substitution involves a positive revenue effect through a higher private good consumption. On the other hand, the local government may gain a competitive advantage over its rival neighbors in the tax competition game.

The central government then should offer an optimal transfer scheme that maximizes the affordable welfare guarantee U^0 and provides optimal local tax incentives. As local cost parameters are private information the local government self-selects a tax policy. By the *revelation principle* we can restrict our search for the best federal policy to direct transfer mechanisms

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

such that truth-telling by all local governments is a Bayesian Nash equilibrium, where the reservation utility U^0 is guaranteed and external effects of tax competition are optimally, not necessary fully, corrected.[2]

As the distribution of cost types is common knowledge the central government correctly anticipates the pure strategy equilibrium $y_i = \hat{y}$ for all i. Please note that the long-term policy is already carried out, but it is unobservable for the central government. This implies the conditional distribution function $P(\theta_i|\hat{y})$ depending on the long-term

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

policy $\hat{y}$. Local governments' calculus at *stage 1* is going to be analyzed in detail below.

The minimization problem of the central government is as follows:

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

$$E_{\theta_{-i}}[V(x_i(t_i(\theta_i,\theta_{-i}))) + z_i(t_i(\theta_i,\theta_{-i})), s_i(\theta_i,\theta_{-i})) - \gamma\hat{y}|\theta_i,\hat{y}] \geq U^0 \tag{11}$$

$$\begin{aligned} &E_{\theta_{-i}}[V(x_i(t_i(\theta_i,\theta_{-i}))) + z_i(t_i(\theta_i,\theta_{-i})), s_i(\theta_i,\theta_{-i})) - \gamma\hat{y}|\theta_i,\hat{y}] \geq \\ &E_{\theta_{-i}}[V(x_i(t_i(\tilde{\theta}_i,\theta_{-i}))) + z_i(t_i(\tilde{\theta}_i,\theta_{-i})), s_i(\tilde{\theta}_i,\theta_{-i})) + \gamma\hat{y}|\tilde{\theta}_i,\hat{y}] \geq \quad \forall i,\theta_i. \end{aligned} \tag{12}$$

Equation (11) ensures that every jurisdiction enjoys at least an expected welfare of U^0. Additionally, we have to consider the Bayesian incentive-compatibility constraints (12). They provide for a truthful revelation of types. Given jurisdiction i's belief with respect to the technology 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 of the direct transfer mechanism proposed by the central government. We can reduce this problem by making use of the optimal transfer scheme in the following Lemma.

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

$$\begin{aligned} s(\theta_i,\theta_{-i}) = \frac{1}{\theta_i} E_{\theta_{-i}}[&U^0 - V(f(k_i) - (r + t_i(\theta_i,\theta_{-i}))k_i + r\bar{k}) - \\ &\theta_i\left(k_i t_i(\theta_i,\theta_{-i}) - y_i\right) - \gamma\hat{y} + \int_{\theta_L}^{\theta_i} k_i t_i(\theta_i,\theta_{-i}) d\theta_i^0 |\theta_i,\hat{y}] \end{aligned} \tag{13}$$

Proof *see Appendix*

To prevent local governments from understating their true types the central government must transfer information rents in addition to the compensatory transfer payments necessary to concede U^0. The last term on the right-hand side of equation (15) depicts the information rent. Therefore, in the incomplete information case the central government's redistribution policy calls for lower contribution rates of efficient regions. As we will see in the next section this will have important implications for the extent to which fiscal externalities are corrected through the system of transfers.

4.2 Tax Incentives

The federal government implements a schedule of tax rates $t(\theta_i, \theta_{-i})$ that minimizes the *expected total* transfer payments. By using (15) we can write:

$$\min_{t_1,\ldots,t_n} \sum_{i=1}^{n} E_{\theta_i}[U^0 - V(x_i(t_i(\theta_i,\theta_{-i})) - \theta_i\left(k_i t_i(\theta_i,\theta_{-i}) - y_i\right) - \gamma\hat{y} + \int_{\theta_L}^{\theta_i} k_i t_i(\theta_i,\theta_{-i}) d\theta_i^0 |\hat{y}]. \tag{14}$$

Integration by parts of (13) yields the following minimization problem[3]:

$$\begin{aligned}\hat{t}_1,\ldots,\hat{t}_n = \arg\min \sum_{i=1}^{n} \int_{\theta_L}^{\theta_H} \cdots \int_{\theta_L}^{\theta_H} [U^0 - V(f(k_i) - (r + t_i(\theta_i,\theta_{-i}))k_i + r\bar{k}) \\ - \left(\theta_i - \frac{1-P(\theta_i|\hat{y})}{p(\theta_i|\hat{y})}\right)(k_i t_i(\theta_i,\theta_{-i}) - y_i) - \gamma\hat{y}][\prod_{i=1}^{n} p(\theta_i|\hat{y})] d\theta_n \cdots d\theta_1\end{aligned} \tag{15}$$

The first order conditions read:

$$\begin{aligned}\left(\theta_i - \frac{1-P(\theta_i|\hat{y})}{p(\theta_i|\hat{y})}\right)\left(k_i + \frac{\partial k_i}{\partial t_i}\hat{t}_i\right) + V_x(x_i)\left(\frac{\partial r}{\partial t_i}(\bar{k} - k_i) - k_i\right) \\ \sum_{j\neq i}\left(V_x(x_j)\frac{\partial r}{\partial t_i}(\bar{k} - k_j) + \left(\theta_j - \frac{1-P(\theta_j|\hat{y})}{p(\theta_j|\hat{y})}\right) t_j \frac{\partial k_j}{\partial t_i}\right) = 0 \quad \text{for all } i.\end{aligned} \tag{16}$$

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 by the optimal incentive-compatible grant. We can state:

Proposition 2 *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.*

[3] As the monotonous hazard rate condition is fulfilled the decision function $t_i(\theta_i)$ is monotonously increasing in θ_i.

The first order condition (16) describes a trade-off between the redistributive objectives of the central government and allocative efficiency. In order to reduce information rents the central government offers transfer schemes that only partially internalize fiscal externalities.

Therefore the surplus which local governments may gain by mispresenting data is a decreasing function of the tax rate. As distorted tax incentives go along with an inappropriate structure of private and public goods it is less attractive for local governments to mispresent their types. The central government uses the fact that high-type regions have a high marginal rate of transformation between private and public good supply z_i. By mispresenting types local governments must then accept an inappropriate mix of private and public goods.

Nevertheless, a marginal reduction of the matching rate goes along with a twofold welfare loss. Firstly, given a lower matching rate external effects of tax competition are not fully internalized and public goods are under-provided. Secondly, as the matching rate is increasingly distorted for lower types the wedge between heterogenous local tax rates is increased. As the hazard rate is an increasing function of the θ_i the matching rate is increasingly distorted for low types. This has a negative impact on the allocation of capital in the economy expressed by a lower net return of capital r. 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. Therefore the central government faces a real trade-off between allocative efficiency and distributive progressivity of the transfer scheme. In the next subsection we will show in which way the second best optimal transfer scheme may influence incentives for long-term decision.

4.3 Incentives for long-term policy

In this subsection we would like to analyze local governments' incentives to pursue sustainable urban 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*. Hence, the transfer scheme derived in subsection 4.1 can also be interpreted as a conservative estimation of local governments: They can at least expect an information rent given by equation (13).

The objective function is:

$$\max_{y_i} E_{\theta_i}[V(x_i(t_i(\theta_i, \theta_{-i}))) + z_i(t_i(\theta_i, \theta_{-i}), s_i(\theta_i, \theta_{-i})) + \gamma y_i)|y_i], \tag{17}$$

where $s(\theta_i, \theta_{-i})$ denotes the incentive-compatible transfer (13). Local governments know that the central government correctly anticipates the policy $\hat{y}$. The first order condition reads:

$$1 = \gamma + \int_{\theta_L}^{\theta_H} \hat{t}_i k_i P_{y_i}(\theta_i|y_i) d\theta_i. \tag{18}$$

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 3 *In an incomplete information set-up the regionally benevolent governments invest an inefficiently low amount in long-term 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 a both a lower supply of public goods and less investments in long-term projects, because they 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 too lax environmental policy.

Secondly, 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 betimes are likely to dispose of efficient technologies and gain from information rents. Therefore the widespread commitment problem of the central government who 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 future efficiency on their own initiative.

5 Concluding Remarks

In this paper we have investigated local governments's incentives to decentrally provide local public goods in a federal state when federal transfers are payed ex post. Intrinsically, the central government cannot make jurisdictions residual claimant of there own policy decision. Firstly, the central government can observe all relevant local data to tailor grants to region-specific circumstances and there must offer grants contingent on observable local policy measures. Then, local governments try to substitute tax revenue for higher-grants-in aid in order to attract new industries. Secondly, a federal government has often no means to punish unsound long-term policy taken by local governments. By constitutional law a minimum welfare is guaranteed or local governments are insured in the case of negative local shocks. Shortcomings of infrastructure policy often bear high consequential cost in the future and burden high fiscal needs on regional governments. If grants are offered ex post local decision makers are apt to take the risk of higher consequential cost by postponing costly long-term projects.

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 progressivity of the transfer scheme is limited. This has important implications for a sustainable policy on the local level. We show to which extent the Good Samaritan Problem is mitigated through incentives for local policy in a setting with a second best optimal Bayesian transfer mechanism.

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7 Appendix

7.1 Proof of Proposition 1

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 dirty 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 $\hat{y}$ [$\tilde{y}$]:

$$\int_{\theta_L}^{\theta_H} \theta_i \tilde{t}(\theta_i) k_1 P(\theta_i|\tilde{y}) d\theta_i + \gamma\tilde{y} \geq \int_{\theta_L}^{\theta_H} \theta_i \tilde{t}(\theta_i) k_1 P(\theta_i|\hat{y}) d\theta_i + \gamma\hat{y}, \tag{19}$$

$$\int_{\theta_L}^{\theta_H} \theta_i \hat{t}(\theta_i) k_2 P(\theta_i|\hat{y}) d\theta_i + \gamma\hat{y} \geq \int_{\theta_L}^{\theta_H} \theta_i \hat{t}(\theta_i) k_2 P(\theta_i|\tilde{d}) d\theta_i + \gamma\tilde{y}. \tag{20}$$

Adding up (21) and (22) yields

$$\int_{\theta_L}^{\theta_H} \theta_i (\hat{t}(\theta_i) - \tilde{t}(\theta_i))(P(\theta_i|\tilde{y}) - P(\theta_i|\hat{y})) d\theta_i \geq 0. \tag{21}$$

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 (23) is positive or equal to zero. q.e.d.

7.2 Single-crossing property

For the further analysis the following property is necessary that jurisdictions with high types have a higher willingness to tax capital than their low efficient neighbors. In physical terms a jurisdiction with a type θ_i can transform one unit of a private good in θ_i units of a public good. A consequence is that a marginal tax increase has an important impact on public good supply in relatively efficient jurisdictions, while this impact is less important in less efficient jurisdictions. We can state as follows:

$$\text{Formally, we can state that} \quad \theta_i > \theta_j \quad \Longrightarrow \quad t_i > t_j \quad \text{for all i, j.}$$

We proof 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:

$$\begin{bmatrix} F^1(\theta_1, \theta_2, t_1, t_2) \\ \\ F^2(\theta_1, \theta_2, t_1, t_2) \end{bmatrix} = 0 \tag{22}$$

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

$$\begin{bmatrix} \frac{\partial F^1}{\partial t_1} & \frac{\partial F^1}{\partial t_2} \\ \\ \frac{\partial F^2}{\partial t_1} & \frac{\partial F^2}{\partial t_2} \end{bmatrix} \begin{bmatrix} \frac{\partial t_1}{\partial \theta_1} \\ \\ \frac{\partial t_2}{\partial \theta_1} \end{bmatrix} = \begin{bmatrix} \frac{-\partial F^1}{\partial \theta_1} \\ \\ \frac{-\partial F^2}{\partial \theta_1} \end{bmatrix} \tag{23}$$

From the first order condition in equation (9) we can derive the followingproperties: [4]

$$\frac{\partial F^i}{\partial t_i} < 0 \quad \text{and} \quad \frac{\partial F^i}{\partial t_j} > 0 \tag{24}$$

$$\frac{\partial F^1}{\partial t_1} > -\frac{\partial F^1}{\partial t_2} \quad \text{and} \quad \frac{\partial F^2}{\partial t_2} > -\frac{\partial F^2}{\partial t_1} \tag{25}$$

$$\frac{\partial F^i}{\partial \theta_i} > \frac{\partial F^i}{\partial \theta_j} \geq 0 \tag{26}$$

[4] It is worth to mention that the derivatives in (26) to (28) all have a proper meaning: The first term in (26) 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) and Tirole (1988) pp. 451 - 452). (27) tells us that there is a unique Nash equilibrium in the tax competition game (see Fudenburg and Tirole (1993) and Tirole (1988) p. 453) and (28) is equivalent with the so-called sorting condition (see Guesnerie and Laffont (1984) and section 4 in this paper).

Applying Cramer's rule to equation (25) yields the following partial derivative:

$$\frac{\partial t_1}{\partial \theta_1} = \frac{1}{|J|} \quad \det \begin{bmatrix} \frac{-\partial F^1}{\partial \theta_1} & \frac{\partial F^1}{\partial t_2} \\ \frac{-\partial F^2}{\partial \theta_1} & \frac{\partial F^2}{\partial t_2} \end{bmatrix} > 0, \tag{27}$$

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.

7.3 Proof of Lemma 1:

We show that total transfer payments are expressed by (15):

- The θ_L-jurisdictions has the less efficient provision technology and needs the highest compensating grants. Therefore the constraint (10) which assures U^0 for each jurisdiction should be binding for type $\theta_i = \theta_L$.

$$E_{\theta_{-i}}\left[V(x_i(t_i(\theta_L), t_{-i}(\theta_{-i}), \theta_L)) + z_i(t_i(\theta_L), t(\theta_{-i}), s(\theta_L)) + \gamma y_i | \theta_L\right] = U^0. \tag{28}$$

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

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

  For truthful mechanisms it applies that $\tilde{\theta}_i = \theta_i$. Totally differentiating the incentive-compatibility constraint (14) yields

$$\frac{\partial U_i(t_i(\theta_i), t(\theta_{-i}), \theta_i)}{\partial \theta_i} = k_i(t_i(\theta_i), t_{-i}(\theta_{-i}))t_i(\theta_i). \tag{29}$$

  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 (31) yields the local welfare including transfer payments:

$$E_{\theta_{-i}}\left[V(f(k_i) - (r+t_i)k_i + r\bar{k}) + \theta_i\left(k_i t_i - \hat{y}\right) + \gamma\hat{y}|\theta_i\right] = E_{\theta_{-i}}\left[U^0 + \int_{\theta_L}^{\theta_i} k_i t_i d\theta_i^0.\right] \tag{30}$$

Note that the constant U^0 is determined by equation (13). 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:

$$s(\theta_i) = \frac{1}{\theta_i} E_{\theta_{-i}}[U^0 - V(f(k_i) - (r+t_i)k_i + r\bar{k}) + \theta_i\left(k_i t_i + s_i(\theta_i)\right) + \int_{\theta_L}^{\theta_i} k_i t_i d\theta_i^0 |\theta_i] \qquad \text{q.e.d.} \tag{31}$$

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