Redistribution and Conditional Grants for All! Federal or Supranational Accountability?*

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Abstract

Very often, federal systems are more sophisticated than assumed in theory. The common assumption that only one central government engages in federal redistribution or corrective grant policy towards regional governments in many cases does not hold. This paper aims at casting some light on this mostly neglected but important issue in economic theory. We focus on federal redistribution in the presence of regional investment externalities with three tiers of government involved. Our results suggest that investment targets of the different levels, as well as corrective policies at the two highest tiers of government are crucially determined by the financing mechanism behind the transfer system and the tax autonomy of the highest level government. The model shows that differently from the US, the federal structure of the EU may not assure first best investment.

Key Words: Federal Redistribution, Conditional Grants, Local Public Investment.

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1 Introduction

Against the common assumption in the theory of fiscal federalism, more than two tiers of government are involved in most federal decision making. E.g. consider the European Union or the US. In both cases there is a central government with some decision power as well as subordinate national or state governments, which again are composed by several regions. Within the European Union some countries are organized beyond three tiers of governments - take Germany or Spain as an example. This results in an even more complex federal structure. On the other hand, comparing the EU with the US shows that the autonomy of the highest government level may vary significantly. E.g. the EU disposes over no tax autonomy but depends on GDP depending transfers of its members. In this context, we investigate how incentives and corrective policies at different levels of government depend on the power delegated to the highest level of government. We are particularly interested in the strategic behavior of the middle level government which is interested in maximizing utility of its own regions but at the same time is involved in a strategic interaction with the highest level government.

In order to understand the complexity of a three tiered federal system, we investigate a federal redistribution system in the presence of vertical investment externalities. Indeed, Dahlby (1996) shows within a two tiered model that a redistribution system generates a need for additional conditional transfers. This result holds if GDP in one region positively depends on its own investment. If a federal redistribution system partially offsets differences in GDP this leads to strategic behavior of all regions to exploit the system: Once a federal redistribution system is in place, regions want to underinvest to attract additional redistribution funds. Optimal regional investment can only be implemented through additional central government intervention. With optimal matching transfers, a positive price effect exactly offsets strategic disincentives and first best investment is restored. In this sense, redistribution generates a need for conditional transfers. If one believes in this reasoning, it is important to understand which additional strategic behavior arises in a more complex federal system with three tiers of government such as the US or the EU. Further, we ask how outcomes and corrective policies depend on the decision power delegated to the highest level government.

Redistribution may be organized at different hierarchical levels of government. First, in a federation with three tiers of government such as the US, federal and state governments mutually redistribute over regions. Second, if several countries join a supranational organization, national government as well as supranational authorities may dispose over redistribution power. Most prominently, the European Union redistributes resources among regions belonging to distinct countries. However, there is a crucial difference between the US system and the federal structure we can observe in the EU: The latter does not dispose over tax autonomy. For this reason it can provide conditional transfers for investment only towards poor regions. With this policy the EU aims at achieving two aims at the same time. At the one hand it has a strong objective to redistribution from rich to poor regions. On the other hand, it still wants to implement optimal regional investment. Figure (1) provides a rough picture of EU- regions eligible for conditional grants through objective 1 or objective 2 of EU structural funds.

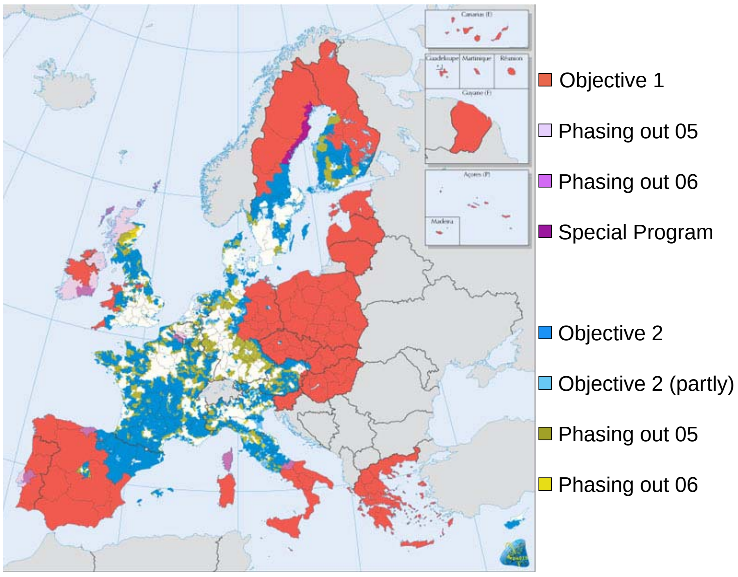

Figure 1: Structural Funds, 2004-2006, Areas eligible under Objective 2 and Objective 1. Source: European Union (2006).

It becomes evident that only poor regions receive conditional transfers emphasizing the strong redistributive character of EU transfers. It is worthwhile noting that matching rates provided by the EU are rather high and amount up to 80 percent. The European Union as highest level redistribution authority pays only conditional transfers for redistributive objectives. Since the EU only provides investment grants to poor regions, these transfers automatically function also as redistribution funds. One may doubt whether this policy implements first best investment in all regions since rich regions are not eligible for conditional transfers. It is the foremost aim of this paper to investigate under which circumstances these concerns are justified.

This paper investigates federal redistribution at the presence of vertical investment externalities with three tiers of government. Within this setting we try to understand the impact of fiscal externalities on the investment targets at different hierarchical levels, their strategic behavior, and implemented corrective policies by the two highest level authorities. Thereby, we will also take into account the impact of tax competences of different redistribution authorities. In order find answers to the issues raised we assume redistribution as exogenously determined by some political process. This allows us to concentrate on investment targets and corrective matching grants policies by the two higher levels.

If redistribution is mutually conducted by a high level (H-government) and a middle level government (M-government), we can distinguish three cases: First, if a federal and a state government share regional redistribution, both dispose over tax autonomy but the financing of matching grants does not generate additional incentives. This setting allows concentrating on the pure disincentive effects on the three tiers of government as they are generated by federal redistribution. Our findings suggest that more redistribution conveyed to the highes level reduces target values for regional as well as state governments. Only the highest level government provides conditional transfers to correct strategic behavior of regions. Second, if one assumes a lump sum tax mechanism to finance corrective matching grant policies. Middle level governments balance the positive inventive from the tax mechanism to the negative effect of the redistribution system as analyzed in case one. In the equilibrium, both middle level and high level governments provide conditional transfers to implement first best investment at the regional level. Third, in a framework where two national governments join a supranational organization, the latter one does not dispose over any tax autonomy. For instance, this can be observed for the EU. As we will see, it can be no longer assured that first best investment is implemented depending on whether EU autonomy is sufficiently large or not.

The paper proceeds as follows. Section 2 provides a short literature overview. Section 3 presents the basic model and underlying redistribution mechanism with two tiers of government. Section 4 extends this setting to a three tiered federal system with mutual redistribution by the two highest levels of governments. We determine the impact of shared redistribution on investment targets of the three tiers of government. Section

4.2. determines matching grant policies adopted by the two higher levels of governments and the implemented levels of regional investment by excluding any additional incentive effects from taxation. This setting is generalized in Section 4.3. where we allow a general lump sum tax to finance matching transfers. Section 4.4. investigates a special case where only the middle tier can raise taxes. Finally, Section 5 concludes.

2 Literature Review

The analysis of intergovernmental grants and federal redistribution are well established in economic theory. A good overall discussion of this issue is provided by Johnson (1988) who proposes a general theory of redistribution. He also refers to problems arising from spillovers and factor mobility. Though, he does not explicitly take into account strategic disincentives generated within the redistribution system itself. Oates (1972) provided an analytical framework justifying conditional grants. He proved optimality of matching grants to account for spillover effects of public goods beyond regional borders. More than one decade later, Inman (1988) doubted whether the widespread use of conditional grants can only be explained by traditional efficiency and spillover arguments. His findings motivated further research to justify conditional grants as a common policy instrument. E.g. Persson, T. and G. Tabellini, (1996), present a general framework of redistribution and taxation, though not explicitly concentrating on fiscal externalities. Based on this literature, noticeable research on information asymmetry, fiscal externalities and conditionality in redistribution systems was conducted. Huber and Runkel (2006) assume information asymmetries among national and regional governments to show that conditional block grants or capped matching grants may be required to implement a second best solution. However, within their model it is not possible to explain conditional grants payment to rich regions only for reasons of redistribution.

Only recently, a new branch of research on vertical fiscal externalities emphasized that conditional grant payments are necessary in order to correct strategic behavior generated within a redistribution system. A first treatment of fiscal externalities in this context was presented by Dahlby (1996) showing that redistribution causes strategic disincentives for regional governments in terms of raising their own tax basis as well as investment into local public goods. This argument is empirically verified by the study of Matheson (2005). He finds significant discouragement effects of regional public investment through federal redistribution in Russia. Similarly, Baretti et al. (2002) show that the redistributive system in Germany generates disincentives e.g. for raising regional tax bases. Recently, Fenge and Wrede (2004) pointed out that redistribution may result in either under- or over-investment. This, of course, crucially determines the optimal matching grant policy to be adopted by the central government. However, they do not discuss the impact of more sophisticated three tiered federal systems on the implemented level of regional investment and optimal matching policies by the two higher levels which may represent national and EU authorities, although explicitly referring to the EU.

The present paper particularly takes into account investment incentives arising from redistribution which is mutually conducted by two higher tiers of government. Although, three tiered federal structures are a rather common phenomenon, only few papers are concerned with this issue. E.g. see Cremer and Pestieau (1996) for a literature review on the distributive implications of European integration. However, in most cases this literature cuts the perspective of regional behavior and thereby falls back on an analysis with two tiers of government, only. One exception are Cremer and Pestieau (1997). They consider income redistribution in a setting with three tiers of government. They identify a trade off between inter- and intra-national redistribution under incomplete information. Differently from their approach, we concentrate on redistribution and fiscal externalities. Setting aside their asymmetric information assumption, we analyze behavior and corrective policies if redistribution is partly shifted from a national to a higher level government.

In a broader sense this paper is also related to the bailout problem prominently examined by Wildasin (1997). He also highlights strategic behavior of regions as means of acquiring additional federal assistance. However, compared to our analysis, Waldasin investigates a rather extreme case concerning strategic jurisdictional bankruptcy. In the present setting, conditional grant payments may be interpreted as instruments to prevent future bailout.

3 Benchmark Case: Two Tiers of Government

This section introduces a benchmark model to investigate disincentives for local public investment generated within a redistribution system. For this purpose consider a federation consisting of one central government and two regions. For the moment abstract from spillover effects of local public investment and let us only refer to income effects of local public investment. This allows identifying the pure strategic argument within this framework. Besides the central government, the federation is constituted by N regions of type 1 and of type 2 each. The two types only differ in marginal productivity parameter ρ_i. Logarithmic production in region i depends on productivity factor ρ_i as well as its public investment I_i:

$$Y_i = \rho_i \cdot lnI_i \tag{1}$$

The analysis is conducted from the perspective of a particular region of type 1, but results directly apply to any other region. You may want to interpret I_1 as a public input such as infrastructure or schooling outlays. [1]

A representative individual in region 1 exclusively enjoys utility from private consumption C_1. For ease of calculation, local public investment is assumed to generate no direct utility. Individuals only benefit from regional public investment through increases in per capita income. The private budget constraint reads

$$C_1 = Y_i(\cdot) + b \cdot \left(\frac{\sum_k^{2N} Y_k(\cdot)}{2N} - Y_1(\cdot) \right) - I_i.$$

Redistribution parameter $b \, \epsilon \, [0, 1]$ can be interpreted as the rate at which the income gap between the two types of regions is equalized. For $b = 0$ no redistribution is effectuated, for $b = 1$ regional differences in GDP are completely offset through redistribution transfers.

Regional governments maximize utility of a representative consumer. With the private budget constraint, the regional objective function writes

[1] This whole mechanism does not exactly correspond to what can be observed in reality. Usually, transfers are determined on basis of GDP in precedent years and investment leads to benefits only in some future period. However, introducing dynamics into the model complicates the analysis without providing further insights

$$U(C_1) = U\left(Y_1(I_1) + b \cdot \left(\frac{\sum_k^{2N} Y_k(\cdot)}{2N} - Y_1(\cdot)\right) - (1-\gamma_1)\cdot I_1\right)$$

The central government maximizes utilitarian welfare.[2]

$$W = \sum_i^{2N} U\left(Y_i(I_i) + b \cdot \left(\frac{\sum_k^{2N} Y_k(\cdot)}{2N} - Y_1(\cdot)\right) - I_i\right) \tag{2}$$

3.1 Regional Behavior

In this section, we characterize disincentive effects of redistribution on regional investment in a federation with two types of regions and one central government. Maximizing the objective functions of the central and regional government specified above wrt. I_1 yields

Proposition 3.1 *Given a b-redistribution system, both rich and poor regional governments have an incentive to under-invest.*

Proof FOC of central government

$\frac{\partial W^M}{\partial \gamma_1} = U_1' \cdot \left(\frac{\partial Y_1(I_1^*)}{\partial I_1^*}\frac{\partial I_1^*}{\partial \gamma_1}(1-\frac{b}{2N}) + \frac{I_1^*}{2N} - (1-\frac{\gamma_1}{2N})\frac{\partial I_1^*}{\partial \gamma_1}\right)$

$+U_1' \cdot (N-1) \cdot \left(\frac{\partial Y_1(I_1^*)}{\partial I_1^*}\frac{\partial I_1^*}{\partial \gamma_1}\frac{b}{2N} + \frac{I_1^*}{2N} - (1-\frac{\gamma_1}{2N})\frac{\partial I_1^*}{\partial \gamma_1}\right)$

$+U_2' \cdot N \cdot \left(\frac{\partial Y_1(I_1^*)}{\partial I_1^*}\frac{\partial I_1^*}{\partial \gamma_1} \cdot \frac{b}{2N} - \frac{I_1^*}{2N} - \frac{\gamma_1}{2N}\frac{\partial I_1^*}{\partial \gamma_1}\right)$

which simplifies to $\frac{\partial Y_1(I_1^*)}{\partial I_1^*} = \frac{1}{1-\frac{b}{2}+\frac{U_2'}{U_1'}\cdot\frac{b}{2}}$.

FOC of the regional government without central matching grants writes

$\frac{U(C_1)}{\partial I_1} = U'(C_1) \cdot \left(\frac{\partial Y_1(I_1)}{\partial I_1}\left(1-\frac{b}{2N}\right) - (1-(1-\frac{1}{2N})\cdot\gamma_1)\right) = 0$

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[2]Note that in this specification the central government wants to choose b such that marginal utilities are equalized over regions since

$$N \cdot U'(C_1) \cdot \left(\frac{\sum_k^{2N} Y_k(\cdot)}{2N} - Y_1(\cdot)\right) + N \cdot U'(C_2) \cdot \left(\frac{\sum_k^{2N} Y_k(\cdot)}{2N} - Y_2(\cdot)\right) = 0$$

However, since we are interested in how different governmental hierarchies react to a redistribution system, parameter b is assumed to be exogenously given for the rest of this paper.

Rewrite: $\frac{\partial Y_1(I_1)}{\partial I_1} = \frac{(1-(1-\frac{1}{2N})\cdot\gamma_1)}{1-\frac{b}{2N}}$ which is larger than the marginal productivity objective of the central government for $b \,\epsilon\, [0,1]$ and $N \geq 1$. This holds for both types of regions. ■

Fiscal externalities arise due to federal redistribution. Therefore, regions are interested in behaving strategically: Compared to the maximization problem of a benevolent central government, regions benefit from underinvesting. Taking the level of redistribution, b, as given, each region is aware of both positive income effects of their investment as well as its negative impact on redistribution transfers received from other regions. A rich region realizes that part of its higher income generated through higher investment efforts will be transferred to poor regions. On the other hand, for a poor region, higher investment results in less transfers received from rich regions. Compared to first best investment, both types of regions do not take into account positive effects of own investment on other regions through reduced transfer obligations. This results in overall under-investment which can not be relieved without additional intervention by the center.

3.2 First Best Corrective Policy

Since redistribution provides incentives for regions to underinvest, there are two objectives to be achieved by the center at the same time. First, an exogenously given degree of redistribution among regions has to be assured. Second, first best investment has to be achieved by introducing corrective policies. In line with standard public finance literature, corrective matching grants are the most efficient instrument to provide sufficient incentive for regional agents to implement a central objective. This reasoning imposes the following structure:

1. b is determined exogenously.
2. Anticipating regional behavior, the central goverment determines γ_1 .
3. Regional government invests $I_1(\gamma_i, b)$ taking b as given.

If regional government 1 receives a conditional matching transfer from the central government, its budget-constraint rewrites

$$C_1 = Y_1(I_1) + b \cdot \left(\frac{\sum_k^{2N} Y_k(\cdot)}{2N} - Y_1(\cdot) \right) - (1-\gamma_1) \cdot I_1 - T_1.$$

γ_i is the matching rate received by region i from the center. Note that matching transfers are financed by a lump sum tax T_i, with

$$T_i = \frac{\sum_i^{2N} \gamma_i \cdot I_i}{2N}.$$

Since regions differ in productivity, first best investment in productive regions is higher than in unproductive regions. This feature of the model intrinsically justifies why there are income differences between rich and poor regions after central government intervention. Solving backwards leads to

Proposition 3.2 *i) In a b-redistribution system, the central governments provides* $\gamma_1 = 1 - \frac{1-\frac{b}{2N}}{(1-\frac{1}{2N})\cdot(1-\frac{b}{2}+\frac{U_2'}{U_1'}\cdot\frac{b}{2})}$. *The targets of the central government for redistribution as well as for regional investment are implemented. ii) The matching rate for poor regions is higher than for rich regions.*

Proof i) Solving backwards, we first determine behavior of the regional government. Its maximization problem wrt. I_1 yields $I_1^* = \frac{\rho_1(1-\frac{b}{2N})}{1-(1-\frac{1}{2N})\cdot\gamma_1}$

From the central government's maximization problem wrt. γ_1 we derive $\frac{\partial Y_1(I_1^*)}{\partial I_1^*} = \frac{1}{1-\frac{b}{2}+\frac{U_2'}{U_1'}\cdot\frac{b}{2}}$. Putting these two results together, the optimal matching rate is determined by $\gamma_1 = 1 - \frac{1-\frac{b}{2N}}{(1-\frac{1}{2N})\cdot(1-\frac{b}{2}+\frac{U_2'}{U_1'}\cdot\frac{b}{2})}$. This implements first best investment. ■

ii) If region 1 is poor compared to a region of type two, $U_2' > U_1'$ This in γ_1 yields the result.

From proposition 3.2. we know that without further central intervention and for a given level of redistribution, b, regional governments underinvest. To correct for strategic behavior, the central government provides additional matching grants for regional investment. If the central government finances a share γ of regional investment, regions effectively face lower cost of investment and therefore are willing to invest more. This mechanism assures overall efficiency: The central government can meet the exogenously determined redistributive target and at the same time assure first best investment of regional governments.

Note, that the matching rate depends on relative marginal utilities. A poorer region faces higher marginal utility from additional investment. Therefore, the central government is ready to provide a higher matching rate to the poor. Though, this matching rate does not implement the same level of investment as for rich regions due to lower productivity of the poor.

4 Analysis with Three Tiers of Government

Disincentive structures and optimal corrective policies are much more complex in a federal system with 3 tiers of government, as for instance in the US and the EU. This holds since two tiers of government with two distinct objectives mutually redistribution and at the same time engage in corrective policy making towards the regions. As we will see, there are crucial differences between the US and EU: In the US, Federal and a State Government dispose over tax autonomy to finance matching transfers. In the EU, only national governments can raise taxes to finance additional matching transfers, whereas the supranational government does not. For the moment the central government which may either represent a federal or supranational government is labeled high level- or H-government. The state or national governments in-between are called middle level- or M-governments.

In particular, assume two middle level governments, A and B, both consisting of $2N$ regions. N regions of type 1 and 2 belong to the middle level federation A, N regions of type 3 and 4 constitute middle level federation B. The high level government is concerned with $4N$ regions. This structure is portrayed in Figure(2).

From the perspective of a regional government, redistribution transfers are then determined by two institutions at different hierarchical levels. The region is only concerned with utility in its own jurisdictions and maximizes utility of the representative voter. Adopting again the perspetive of a particular region of type 1, the regional objective functions writes

$$U(C_1) = U\left(Y_i + (b-c)\cdot\left(\frac{\sum_k^{2N} Y_k}{2N} - Y_1\right) + c\cdot\left(\frac{\sum_k^{4N} Y_k}{4N} - Y_1\right) - I_i\right) \qquad (3)$$

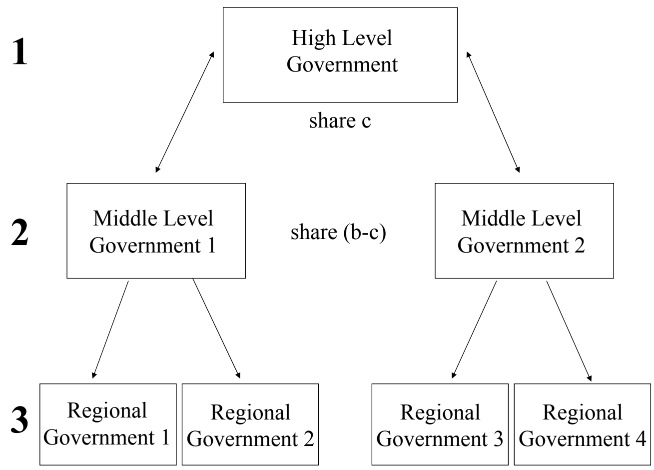

Figure 2: Redistribution with three hierarchical levels of government

with $b, c \epsilon [0, 1]$ assumed to be exogenously given and $b \geq c$. We define $Y_i(\cdot) = Y_i(I_i) = Y_i$. c represents the share of redistribution assigned to the high level government. Since middle level as well as high level governments are engaged in redistribution, the redistribution transfers now appears more complex in the budget constraint. A share $(b - c)$ of redistribution is conducted by the middle level government. Transfers from this tier of government have the same structure as before since a middle level government only considers $2N$ regions. The high level government compares regional GDP with average GDP over all $4N$ regions and than closes this gap by a share c. With this notation, a share c of redistribution is transferred from the middle level government to the high level government. If 10 percent of income differences are to be covered on the highest level, the middle level government reduces its share of redistribution by the same percentage. This formulation assures that we only capture the pure effect of a shift in redistribution responsibility while keeping the overall level of redistribution unchanged. The middle level government considers utilitarian welfare of its $2N$ regions:

$$W^M = \sum_i^{2N} U \left(Y_i + (b-c) \cdot \left(\frac{\sum_k^{2N} Y_k}{2N} - Y_1 \right) + c \cdot \left(\frac{\sum_k^{4N} Y_k}{4N} - Y_1 \right) - I_i \right). \quad (4)$$

Finally, the high level government maximizes utility over all $4N$ regions:

$$W^H = \sum_i^{4N} U\left(Y_i + (b-c)\cdot\left(\frac{\sum_k^{2N} Y_k}{2N} - Y_1\right) + c\cdot\left(\frac{\sum_k^{4N} Y_k}{4N} - Y_1\right) - I_i\right). \quad (5)$$

We first investigate the impact of c on incentives of the three levels of government concerned with regional investment. Afterwards, we determine the impact of c on optimal corrective policies within this structure. We distinguish two cases: Section 4.2. focuses on federal vs state redistribution disregarding additional tax effects from the financing mechanism for matching transfers. Section 4.3. extends this setting to account for additional investment incentives generated by a general lump sum tax rule to finance corrective policies. Section 4.4. investigates a case where only the middle level government disposes over tax autonomy.

4.1 Comparative Statics

The first natural issue is to identify effects of an increase in c on investment incentives of regional, middle level and high level governments. Note that regions can realize their own preferred level of investment, as long as M- and H-governments do not dispose over matching transfers as additional policy instrument. The investment target of the middle level government for region i is labeled I_i^M, the target for the high level is labeled I_i^H. These values are determined by maximizing Equation (4) and Equation (5) with respect to I_i respectively. This leads to

Proposition 4.1 *With b-c-redistribution implemented jointly by H and M governments,*

i) Investment incentives in region 1 *strictly decrease in* N*, b, and c:* $\frac{\partial I_1}{\partial b} < 0$, $\frac{\partial I_1}{\partial c} < 0$, $\frac{\partial I_1}{\partial N} < 0$*, for* $N \geq 1$.

ii) The regional investment target of the M-government is independent of N. $\frac{\partial I_1^H}{\partial c} < 0$. *But* $\frac{\partial I_1^M}{\partial b} < 0$ *if and only if* $U_2' < U_1'$.

iii) The regional investment target of the H-government is independent of N. *Further* $\frac{\partial I_1^H}{\partial b} < 0$ *if and only if* $U_2' < U_1'$. $\frac{\partial I_1^M}{\partial c} < 0$ *if and only if* $U_1' + U_2' > U_3' + U_4'$.

iv) Regional Investment target of H exceeds the target of M, therefore $I_1^* < I_1^M < I_1^H$.

Proof i) Differntiation of Equation (3) wrt. I_1 yields FOC for the regional government:

$\frac{U(C_1)}{\partial I_1} = U'(C_1) \cdot \Big(\frac{\partial Y_1(I_1)}{\partial I_1} \big(1 + (b-c) \cdot \big(\frac{1}{2N} - 1\big) + c \cdot \big(\frac{1}{4N} - 1\big)\big) - 1 \Big) = 0$. Transformation yields $I_1^* = \rho_1 \cdot \big(1 - b + \frac{b-c}{2N} + \frac{c}{4N}\big)$. First derivatives yield the desired result: $\frac{\partial I^*}{\partial N} = \rho_1 \cdot \Big(-2\frac{b-c}{(2N)^2} + -4\frac{c}{(4N)^2}\Big) < 0$; $\frac{\partial I^*}{\partial b} = \rho_1 \cdot \big(-1 + \frac{1}{2N}\big) < 0$ for $N \geq 1$; $\frac{\partial I^*}{\partial c} = \rho_1 \cdot \big(\frac{-1}{2N} + \frac{1}{4N}\big) < 0$.

ii) Differntiation of Equation (4) wrt. I_1 yields FOC for the middle level government:
$\frac{\partial W^M}{\partial I_1} = U_1' \cdot \Big(\frac{\partial Y_1(I_1)}{\partial I_1} \cdot (1 + (b-c)(\frac{1}{2N} - 1) + c(\frac{1}{4N} - 1)) - 1\Big)$
$+(N-1) \cdot U_1' \cdot \Big(\frac{\partial Y_1(I_1)}{\partial I_1} \cdot (b-c)(\frac{1}{2N}) + c(\frac{1}{4N}) \cdot \frac{\partial Y_1(I_1)}{\partial I_1}\Big)$
$+N \cdot U_2' \cdot \Big(\frac{\partial Y_1(I_1)}{\partial I_1} \cdot (b-c)(\frac{1}{2N}) + c(\frac{1}{4N}) \cdot \frac{\partial Y_1(I_1)}{\partial I_1}\Big) = 0$. This simplifies to $I^M = \rho_1 \cdot \Big((1 - \frac{b-c}{2} - \frac{3 \cdot c}{4}) + \frac{U_2'}{U_1'} \cdot \big(\frac{b-c}{2} + \frac{c}{4}\big)\Big)$First derivatives yield the desired result: $\frac{\partial I^M}{\partial N} = 0$; $\frac{\partial I^M}{\partial b} = \rho_1 \cdot \Big(\frac{-1}{2} + \frac{U_2'}{U_1'} \cdot \frac{1}{2}\Big) < 0$ for $U_2' < U_1'$; $\frac{\partial I^M}{\partial c} = \rho_1 \cdot \Big(-\frac{1}{4} - \frac{U_2'}{U_1'} \cdot \frac{3}{4}\Big) < 0$

iii) Differntiation of Equation (5) wrt. I_1 yields FOC of the H-government:
$\frac{\partial W^M}{\partial I_1} = U_1' \cdot \Big(\frac{\partial Y_1(I_1)}{\partial I_1} \cdot (1 + (b-c)(\frac{1}{2N} - 1) + c(\frac{1}{4N} - 1)) - 1\Big)$
$+(N-1) \cdot U_1' \cdot \Big(\frac{\partial Y_1(I_1)}{\partial I_1} \cdot (b-c)(\frac{1}{2N}) + c(\frac{1}{4N}) \cdot \frac{\partial Y_1(I_1)}{\partial I_1}\Big)$
$+N \cdot U_2' \cdot \Big(\frac{\partial Y_1(I_1)}{\partial I_1} \cdot (b-c)(\frac{1}{2N}) + c(\frac{1}{4N}) \cdot \frac{\partial Y_1(I_1)}{\partial I_1}\Big)$
$+N \cdot U_3' \cdot \Big(c(\frac{1}{4N}) \cdot \frac{\partial Y_1(I_1)}{\partial I_1}\Big) + N \cdot U_4' \cdot \Big(c(\frac{1}{4N}) \cdot \frac{\partial Y_1(I_1)}{\partial I_1}\Big) = 0$. This simplifies to $\frac{\partial Y_1(I_1^*)}{\partial I_1^*} = \Big((1 - \frac{b-c}{2} - \frac{3 \cdot c}{4}) + \frac{U_2'}{U_1'} \cdot \big(\frac{b-c}{2} + \frac{c}{4}\big) + \frac{U_3'}{U_1'} \cdot \frac{c}{4} + \frac{U_4'}{U_1'} \cdot \frac{c}{4}\Big) = 1$.First derivatives yield the desired result: $\frac{\partial I^M}{\partial N} = 0$; $\frac{\partial I^H}{\partial b} = \rho_1 \cdot \Big((-\frac{1}{2} + \frac{U_2'}{U_1'} \cdot \big(\frac{1}{2}\big)\Big) < 0$ for $U_2' < U_1'$; $\frac{\partial I^H}{\partial c} > 0$ for $U_1' + U_2' < U_3' + U_4'$

iv) Comparing preferred marginal productiviy level of the M-government with that of the regional goverment yields $\frac{-\frac{1}{2N} + \frac{1}{4N}}{(1 - b + \frac{b-c}{2N} + \frac{c}{4N})^2} > \frac{1}{(1 - \frac{b-c}{2} - \frac{3 \cdot c}{4}) + \frac{U_2'}{U_1'} \cdot \big(\frac{b-c}{2} + \frac{c}{4}\big)}$ for $N \geq 1$ $b, c \in [0, 1]$ and $b \geq c$.

Comparing preferred marginal productiviy level of H-government with that of the M-government yields
$\frac{1}{(1 - \frac{b-c}{2} - \frac{3 \cdot c}{4}) + \frac{U_2'}{U_1'} \cdot \big(\frac{b-c}{2} + \frac{c}{4}\big)} > \frac{1}{(1 - \frac{b-c}{2} - \frac{3 \cdot c}{4}) + \frac{U_2'}{U_1'} \cdot \big(\frac{b-c}{2} + \frac{c}{4}\big) + \frac{U_3'}{U_1'} \cdot \frac{c}{4} + \frac{U_4'}{U_1'} \cdot \frac{c}{4}}$ for $b, c \in [0, 1]$ and $b \geq c$. It follows directly that $I_1^* < I_1^M < I_1^H$. ■

If redistribution authority is shifted towards the high level government, regions are exposed to additional vertical externalities. Therefore, its investment incentive decreases strictly in parameter c. The intuition behind this result is that for higher c, overall redistribution transfers to region 1 react more harshly to an increase in its investment. Benefits of higher investment is not only distributed over a larger set of regions belonging to the high level. Hence, the amount of additional benefits remaining in the region is lower for higher c. Therefore, each region additionally reduces its investment effort for c increasing.

In Section 3 the central government redistributed over $2N$ regions and was interested in implementing first best. In this section now, this central government corresponds to the middle level government. For $c > 0$, the M-government is also exposed to investment disincentives through vertical externalities. This holds since a share c of transfers to regions belonging to a particular middle government is now partly financed by outside regions. It is optimal for the middle level government to reduce its investment target for its regions. This reasoning is more pronounced the higher c. On the other hand, disincentives at the middle level are not as high as on the regional level since the middle level government takes into account the strategic effect of underinvestment among its own regions as it becomes evident by comparing Equation (3) with Equation (4). Note that the investment target of the M-government depends on relative marginal utilities between type 1 and type 2 regions: If a region is poor compared to other regions and c increases, the M-government can increasingly rely on redistribution to raise utility in the poor region than to put investment incentives. Therefore, it reduces its investment target. The opposite reasoning holds for a rich region.

The H-government is not exposed to any strategic disincentive effects generated by either b or c. Its target for regional investment is larger than that of the middle level government. However, its investment objetive is not independent of these two parameters. This is because it still considers the positive impact of the high productivity in a rich region on marginal utility in poor regions. Its investment target for poor regions decreases in b and c, because this makes it easier to increase utility there by making use of higher productivity in rich regions. For the same reason the investment target of the H-goverment for rich regions increases in b and c. Note that we directly fall back to the first best level in Section 3 for $U'(C_1) = U'(C_2) = U'(C_3) = U'(C_4)$ which occurs for identical regions or redistribution which exactly equalizes marginal utilities.

So far, we only investigated preferred regional investment from the perspective of each of the three levels of governments. Without any additional policy instrument, the two higher level governments are unable to influence regional investment decisions. In the following we assume that matching grants are available as additional tool for high and middle level governments. Two settings are interesting for further discussion: Section 4.2. and 4.3. assume that middle level and high level governments dispose over tax autonomy and can impose sufficiently high lump sum taxes to finance their need of matching transfers, resembling the federal structure in the US. Section 4.4. refers to a structure which is closer to the EU where the highest level government can not impose taxes.

4.2 Non-redistributive Financing of Matching Grants

In this section, the financing mechanism for matching transfers does not lead to additional distortions and investment incentives. For this reason consider b and c again as exogenously determined and consider a federal structure as described in Figure (2). For the rest of the paper let us further assume that the number of each type of regions in each country, N, is large. Finally, in order to disregard the effects of marginal utilities which we already analyzed in detail in section $4.1.$, we assume linear utility functions. It is our aim to understand who actually pays conditional transfers and which investment level is implemented. The high level government may be interpreted here as a federal government whereas intermediate governments correspond to state authorities. Both levels dispose over independent tax autonomy. The structure of the model evolves as follows:

1. b and c are assumed to be exogenously fixed.
2. Simultaneous Move Game between M- and H-government on γ_1^M and γ_1^H.
3. regional government 1 invests $I_1(\gamma^M, \gamma^H, b, c)$.

γ_i^M is the region specific matching rate provided by the middle level government and γ_i^H is the region specific matching rate provided by the high level government. Preferences of regional government 1 in Equation (3) are transformed into

$$U\left(Y_1 + (b-c)\left(\frac{\sum_k^{2N} Y_k}{2N} - Y_1\right) + c\left(\frac{\sum_k^{4N} Y_k}{4N} - Y_1\right) - (1 - \gamma_1^M - \gamma_1^H) I_1 - T_1\right)$$

with $T_1 = T_i^M + T_i^H$ and $N \cdot T_i^M = \sum_i^N \gamma_i^M \cdot I_i$, $N \cdot T_i^H = \sum_i^N \gamma_i^H \cdot I_i$. In this setting, matching grants are financed only within groups of identical regions. Therefore, financing matching grants does not generate additional, indirect redistributive effects. We start out with this assumption in order to isolate the impact of direct redistribution on investment an optimal corrective policies.[3] The maximization problem of the H and M-governments are set up accordingly by referring to Equation (4) and Equation (5). Since the number of regions of each type, N is large, regions do not consider the tax effect in their optimization problem. Intuitively, we impose a non-negativity constraint on matching rates, $\gamma_i^H \geq 0$ and $\gamma_i^M \geq 0$. Middle level and high level governments determine their optimal matching rates given the choice of the matching rate on the other level. As Equation (6) shows, γ_i^M and γ_i^H are strategic substitutes. Solving this game backwards leads to

Proposition 4.2 *Assume that redistribution is implemented jointly by M and H and matching transfers are financed by region type specific taxation, T_i^M and T_i^H. Then, the pure redistribution effect leads to a unique Nash Equilibrium with $\gamma^H > 0$ and $\gamma^M = 0$. The first best regional investment target of H, I_1^H, is implemented.*

Proof The proof consists of four steps:

1. Maximization problem of the region yields FOC $\frac{U(C_1)}{\partial I_1} = U'(C_1) \cdot \left(\frac{\partial Y_1(I_1)}{\partial I_1} (1-b) - (1 - \gamma_i^M - \gamma_i^H) \right) = 0$. This yields $I_1^* = \frac{\rho_1(1-b)}{1-\gamma_i^M - \gamma_i^H}$

2. The middle level government chooses γ^M by maximizing its objective function wrt. γ^M. Its FOC writes
$\frac{\partial W^M}{\partial \gamma_1^M} = U_1' \cdot \left(\frac{\partial Y_1(I_1^*)}{\partial I_1^*} \frac{\partial I_1^*}{\partial \gamma_1^M} \cdot (1 + (b-c)(\frac{1}{2N} - 1) + c(\frac{1}{4N} - 1)) - \frac{\partial I_1^*}{\partial \gamma_1^M} \right)$
$+ (N-1) \cdot U_1' \cdot \left(\frac{\partial Y_1(I_1^*)}{\partial I_1^*} \frac{\partial I_1^*}{\partial \gamma_1^M} \cdot (b-c)(\frac{1}{2N}) + c(\frac{1}{4N}) \cdot \frac{\partial Y_1(I_1^*)}{\partial I_1^*} \frac{\partial I_1^*}{\partial \gamma_1^M} \right)$
$+ N \cdot U_2' \cdot \left(\frac{\partial Y_1(I_1^*)}{\partial I_1^*} \frac{\partial I_1^*}{\partial \gamma_1^M} \cdot (b-c)(\frac{1}{2N}) + c(\frac{1}{4N}) \cdot \frac{\partial Y_1(I_1^*)}{\partial I_1^*} \frac{\partial I_1^*}{\partial \gamma_1^M} \right) = 0$. This yields the reaction function of the middle level government $\gamma_i^M = 1 - \gamma_i^H - \frac{1-b}{(1-\frac{c}{2})}$

3. The high level government chooses γ^H by maximizing its objective function wrt. γ^H. Its FOC writes
$\frac{\partial W^H}{\partial \gamma_1^H} = U_1' \cdot \left(\frac{\partial Y_1(I_1^*)}{\partial I_1^*} \frac{\partial I_1^*}{\partial \gamma_1^H} \cdot (1 + (b-c)(\frac{1}{2N} - 1) + c(\frac{1}{4N} - 1)) - \frac{\partial I_1^*}{\partial \gamma_1^H} \right)$
$+ (N-1) \cdot U_1' \cdot \left(\frac{\partial Y_1(I_1^*)}{\partial I_1^*} \frac{\partial I_1^*}{\partial \gamma_1^H} \cdot (1 - (b-c)(\frac{1}{2N} - 1) + c(\frac{1}{4N} - 1)) - \frac{\partial I_1^*}{\partial \gamma_1^H} \right)$

[3] In Section 4.3., we will extend this framework to account for additional incentive effects generated by a general lump sum tax mechanism to finance matching grants.

$+N \cdot U_2' \cdot \left(\frac{\partial Y_1(I_1^*)}{\partial I_1^*} \frac{\partial I_1^*}{\partial \gamma_1^H} \cdot (b-c)(\frac{1}{2N}) + c(\frac{1}{4N}) \cdot \frac{\partial Y_1(I_1^*)}{\partial I_1^*} \frac{\partial I_1^*}{\partial \gamma_1^H} \right)$
$+N \cdot U_3' c(\frac{1}{4N}) \cdot \frac{\partial Y_1(I_1^*)}{\partial I_1^*} \frac{\partial I_1^*}{\partial \gamma_1^H} + N \cdot U_4' c(\frac{1}{4N}) \cdot \frac{\partial Y_1(I_1^*)}{\partial I_1^*} \frac{\partial I_1^*}{\partial \gamma_1^H} = 0$. This yields the reaction function of the middle level government $\gamma_i^H = b - \gamma_i^M$

4. To determine the Simultaneous Move Nash Equilibrium, we substitute γ^H in the reaction function of the M-government which yields $\gamma_i^M = 1 - b + \gamma_i^M - \frac{1-b}{(1-\frac{c}{2})}$ or $0 = 1 - b - \frac{1-b}{(1-\frac{c}{2})}$. There is no interior solution of this problem.

Two potential corner solutions need to be checked given the restriction on parameters, $\gamma_i^M, \gamma_i^M \epsilon [0,1]$:

1: $\gamma_i^H = 0$: In this case $\gamma_i^M = 1 - \frac{1-b}{(1-\frac{c}{2})}$. Plugging into $\gamma_i^H = b - \gamma_i^M$ yields: $\gamma_i^H = (1-b) \cdot (\frac{\frac{c}{2}}{1-\frac{c}{2}}) > 0$, which is a contradiction so this is no equilibrium outcome.

2:$\gamma_i^M = 0$: Plugging into reaction function of H yields $\gamma_i^H = b$. This in reaction function of M yields $\gamma_i^M = (1-b)(\frac{-\frac{c}{2}}{1-\frac{c}{2}}) < 0$. The non zero constraint is binding, therefore, $\gamma_i^M = 0$. The unique Simultaneous Move Nash Equilibrium is a corner solution.

It remains to be shown that γ^H is the first best matching rate from the perspective of the high level government and therefore implements I_1^H.

Plugging γ^M and γ^H from step 4. into the investment decision rule of the regional government, $I_1^* = \frac{\rho_1(1-b)}{1-\gamma_i^M-\gamma_i^H}$, leads to $I_1^* = \frac{\rho_1(1-b)}{1-b} = 1$. This is identical to the first best marginal productivity level desired by the high level government. Hence, with γ^M and γ^H determined in step 4. yield regional first best investment I_1^H. ■

Mutual middle level and high level redistribution leads to conditional grants only provided by the high level government. M-governments only provide lumps sum transfers in order to meet their redistribution aim depending on the value of $(b-c)$. The target of high level for regional investment differs from the middle level target. The M-government wants its regions to invest below the first best level preferred by the high level government. This allows its own regions to attract additional redistribution transfers from outside. On the other hand, the high level wants to make available a matching rate above the preferred level of the M-government. Since it completely takes into account externalities, it is not driven by any incentives and aims at implementing first best. The middle level reduces its matching rate in order to prevent investment beyond its own target. This in turn leads to under-investment from the perspective of the high level government which therefore increases its matching rate even further. This line of argument results in a corner solution: None of the two governments wants to deviate:

the middle level government would like to reduce its matching rate but is bounded from below by constraint $\gamma^M \epsilon [0, 1]$ such that it offers not investment grants at all, $\gamma^M = 0$. The high level government does not deviated since it can implement its optimal policy target by choosing its matching rate $\gamma^H > 0$ high enough.

Referring to a federal structure in the US, this implies that federal redistribution is mutually organized by federal and state governments. In addition to that, the federal government provides conditional grants for regional investment to implement overall efficiency whereas state governments do not provide any conditional transfers.

4.3 Redistributive Financing of Matching Grants

We consider again c as fixed. The number of each type of regions in each country, N is larger and preferences are linear in consumption. Middle as well as high level government diposes over tax autonomy and the right to provide matching transfers. The maximization objective of regional government 1 is similar to Equation (6) except that taxes are now defined by $T_1 = T_i^M + T_i^H$ whith $4 \cdot N \cdot T_i^M = \sum_i^{4N} \gamma_i^M \cdot I_i$ and $2 \cdot N \cdot T_i^H = \sum_i^{2N} \gamma_i^H \cdot I_i$. In this sense, there arises an additional redistributive effect through the financing mechanism of matching grants: Region and Middle level governments take into account that matching grants are partly financed outside their own borders. This implies additional incentives effects disregarded in Section 4.2. Note that since the number of regions of each type, N is large, regions do not consider the tax effect in their optimization problem. Solving the simultaneous move game backwards leads to

Proposition 4.3 *Assume that redistribution is implemented jointly by a middle level and high level government and taxation occurs country and union wide, respectively.*

i) Then, in the unique Nash Equilibrium, $\gamma^H = c$ and $\gamma^M = b - c$ for the M-government corresponding to their share of redistribution.

ii) In the unique interior solution, first best investment is implemented and investment targets of H and M are identical, $I_1^H = I_1^M$.

Proof i) The proof consists of four steps:

1. Maximization problem of the region yields FOC
$\frac{U(C_1)}{\partial I_1} = U'(C_1) \cdot \left(\frac{\partial Y_1(I_1)}{\partial I_1} (1-b) - (1 - \gamma_i^M - \gamma_i^H) \right) = 0$. Solving yields $I_1^* = \frac{\rho_1 (1-b)}{1-\gamma_i^M - \gamma_i^H}$

2. The middle level government chooses γ^M by maximizing its objective wrt. γ^M. Its FOC writes $\frac{\partial W^M}{\partial \gamma_1^M} = U_1' \cdot (\frac{\partial Y_1(I_1^*)}{\partial I_1^*}\frac{\partial I_1^*}{\partial \gamma_1^M} \cdot (1+(b-c)(\frac{1}{2N}-1)+c(\frac{1}{4N}-1))+(1-\frac{1}{2N}) \cdot I_1^*$
$-((1-\gamma_i^M-\gamma_i^H)+\frac{\gamma_1^M}{2N}+\frac{\gamma_1^H}{4N})\frac{\partial I_1^*}{\partial \gamma_1^M})$
$+(N-1) \cdot U_1' \cdot \Big(\frac{\partial Y_1(I_1^*)}{\partial I_1^*}\frac{\partial I_1^*}{\partial \gamma_1^M} \cdot \big((b-c)(\frac{1}{2N})+c(\frac{1}{4N})\big) - (\frac{1}{2N}) \cdot I_1^* - (\frac{\gamma_1^M}{2N}+\frac{\gamma_1^H}{4N})\frac{\partial I_1^*}{\partial \gamma_1^M}\Big)$
$+N \cdot U_2' \cdot \Big(\frac{\partial Y_1(I_1^*)}{\partial I_1^*}\frac{\partial I_1^*}{\partial \gamma_1^M} \cdot \big((b-c)(\frac{1}{2N})+c(\frac{1}{4N})\big) - (\frac{\gamma_1^M}{2N}+\frac{\gamma_1^H}{4N})\frac{\partial I_1^*}{\partial \gamma_1^M}\Big) = 0$. This yields the reaction function of the middle level government $\gamma_1^M = 1-\gamma_1^H - \frac{4-2 \cdot b-c}{(4-2 \cdot b-c)+\frac{U_2'}{U_1'}(2 \cdot b-c)}$

3. The high level government chooses γ^H by maximizing its objective wrt. γ^H. Its FOC writes $\frac{\partial W^H}{\partial \gamma_1^H} = U_1' \cdot (\frac{\partial Y_1(I_1^*)}{\partial I_1^*}\frac{\partial I_1^*}{\partial \gamma_1^H} \cdot (1+(b-c)(\frac{1}{2N}-1)+c(\frac{1}{4N}-1))+(1-\frac{1}{4N}) \cdot I_1^*$
$-((1-\gamma_i^M-\gamma_i^H)+\frac{\gamma_1^M}{2N}+\frac{\gamma_1^H}{4N})\frac{\partial I_1^*}{\partial \gamma_1^H})$
$+(N-1) \cdot U_1' \cdot \Big(\frac{\partial Y_1(I_1^*)}{\partial I_1^*}\frac{\partial I_1^*}{\partial \gamma_1^H} \cdot \big((b-c)(\frac{1}{2N})+c(\frac{1}{4N})\big) - (\frac{1}{4N}) \cdot I_1^* - (\frac{\gamma_1^M}{2N}+\frac{\gamma_1^H}{4N})\frac{\partial I_1^*}{\partial \gamma_1^H}\Big)$
$+N \cdot \Big(\frac{\partial Y_1(I_1^*)}{\partial I_1^*}\frac{\partial I_1^*}{\partial \gamma_1^H} \cdot \big((b-c)(\frac{1}{2N})+c(\frac{1}{4N})\big) - (\frac{1}{4N}) \cdot I_1^* - (\frac{\gamma_1^M}{2N}+\frac{\gamma_1^H}{4N})\frac{\partial I_1^*}{\partial \gamma_1^H}\Big)$
$+N \cdot U_3' \cdot \Big(c(\frac{1}{4N}) \cdot \frac{\partial Y_1(I_1^*)}{\partial I_1^*}\frac{\partial I_1^*}{\partial \gamma_1^H} - (\frac{1}{4N}) \cdot I_1^* - (\frac{\gamma_1^H}{4N})\frac{\partial I_1^*}{\partial \gamma_1^H}\Big)$
$+N \cdot U_4' \cdot \Big(c(\frac{1}{4N}) \cdot \frac{\partial Y_1(I_1^*)}{\partial I_1^*}\frac{\partial I_1^*}{\partial \gamma_1^H} - (\frac{1}{4N}) \cdot I_1^* - (\frac{\gamma_1^H}{4N})\frac{\partial I_1^*}{\partial \gamma_1^H}\Big) = 0$. This yields the reaction function of the middle level government$\gamma_i^H = b - \gamma_i^M$

4. To determine the Simultaneous Move Nash Equilibrium, we substitute γ^H in the reaction function of the middle level government which yields.

$\gamma_i^M = 1 - b + \gamma_i^M - \frac{1-b}{(1-\frac{c}{2})} \cdot \Big(1 - \frac{b-\gamma_i^M}{2}\Big)$ which simplifies to $\gamma_i^M = b - c > 0$. Substitution into the reaction function of the high level government yields directly

$\gamma_i^H = c$.

We still need to check two potential cornersolutions given the restriction on parameters, $\gamma_i^M, \gamma_i^M \epsilon [0,1]$:

1: $\gamma_i^H = 0$: In this case $\gamma_i^M = 1 - \frac{1-b}{(1-\frac{c}{2})}$. Plugging this into into $\gamma_i^H = b - \gamma_i^M$ yields $\gamma_i^H = (1-b) \cdot (\frac{\frac{c}{2}}{1-\frac{c}{2}}) > 0$, which is a contradiction.

2:$\gamma_i^M = 0$: In this case $\gamma_i^H = b$. Plugging into $\gamma_i^M = 1 - \gamma_i^H - \frac{1-b}{(1-\frac{c}{2})} \cdot \Big(1 - \frac{\gamma_1^H}{2}\Big)$ yields $\gamma_i^M = (1-b)(1 - \frac{1-\frac{b}{2}}{1-\frac{c}{2}}) > 0$ for $b > c$ which is a contradiction. The unique equilibrium of this game is an interior solution.

Finally, it remains to be shown that γ^H and γ^M together implement first best investment, I_1^H.

Plugging γ^M and γ^H from step 4. into the investment decision rule of the regional government, $\frac{\partial Y_1(I_1)}{\partial I_1} = \frac{1-\gamma_i^M-\gamma_i^H}{1-b}$, yields $\frac{\partial Y_1(I_1)}{\partial I_1} = \frac{1-b+c-c}{1-b} = 1$. This is identical to the first best marginal productivity level desired by the high level government. Hence, with γ^M and γ^H determined in step 4. yield regional first best investment I_1^H.

ii) In the unique Nash equilibrium both have the same investment target. Then, neither M nore H want to deviate. From the maximization problem of M: $\frac{\partial Y_1(I_1^*)}{\partial I_1^*}(1-\frac{c}{2}) = 1 - \frac{\gamma_1^H}{2}$ plugging in matching rate of H:$\frac{\partial Y_1(I_1^*)}{\partial I_1^*} = 1$ which corresonds to the investment target of H. ■

In this setting there is an new investment incentive for the middle level government through the indirect redistribution effect of the matching grant financing mechanism. Differently from the direct redistribution effect, the tax effect positively affects the investment target of the middle level government. The middle level government knows that higher regional investment attracts additional funds from outside regions. This incentive effect works since matching grants on the high level are financed evenly by all regions. The middle level government increases its target compared to the case where taxes do not generate additional redistribution effects. Note that this argument does not hold for regional authorities. Since the number of regions, N, is large, regions consider their own contribution to its matching grant receipt as negligible in both cases.

Note that the investment objective of the middle level government positively depends on γ_1^H. This holds because γ_1^H raises the potential of attracting additional funds from outside through an increase in regional investment. On the other hand the potential of exploiting the redistribution system through underinvestment remains unchanged. Compared to Section 4.2. the regional investment target of the middle level government increases. This is also revealed by solving the FOC of the middle level for marginal productivity, $\frac{\partial Y_1(I_1^*)}{\partial I_1^*}(1-\frac{c}{2}) = 1 - \frac{\gamma_1^H}{2}$. Higher γ_i^H leads to a lower target for marginal productivity and therefore higher investment.

In the only Nash Equilibrium, the high level sets its matching grants at a level the raises the investment target of the middle level up to the first best level. Only in this case the positive tax effect neutralizes the negative redistribution effect on the investment target of the M-government. A matching grant above this level is not optimal since this would lead the M-government to increase its investment target beyond the target of the higher level in order to exploit the financing system behind γ_1^H. A matching rate below this level is not optimal since it would make the M-government to reduces its investment target and we would fall back to the corner-solution outlined in Section 4.2. However, this can be no equilibrium. The H-government knows that a high γ_1^H introduces additional distortions through its financing mechanism. Therefore, it wants γ_1^M, which causes less tax effects, to be as high as possible. This leads to the unique and stable Nash Equilibrium described above.

For the matching grant policy in a federal system such as the US this implies that the federal government has to weigh the effect of redistribution against the incentives arising through the financing system of matching transfers. By assuring first best regional investment, it has to take into account that conditional transfers from different levels of government generate different tax effects for state governments.

4.4 High Level Government without Tax Autonomy

Consider again a federal structure as in Figure (2). However, now two independent nations are assumed to constitute a supranational federation. The highest level government therefore represents a supranational government body. Again, a fixed share c of redistribution authority is shifted towards the highest level. Differently from the analysis in Section 4.2. and 4.3., only national governments can impose taxes. This setting is similar to what we observe within the European Union: the high level government does not dispose over any tax autonomy and losses therefore its preferred tool to finance matching grants. For the regional budget constraint this implies $T = T^M$. The only way to pay conditional transfers for the supranational government is to directly put an investment condition on its redistribution transfers.

Assume again that regional governments do not consider the financing mechanism behind matching transfers. This allows us to maintain the disincentive effect from redistribution and the possibility to provide redistribution funds conditional on investment at the same time. The high level government faces an additional budget constraint. Since it disposes over no tax autonomy, it can provide conditional matching grants only from disposable redistribution funds that is

$$\tau_i + \gamma^H \cdot I_1 \leq c \cdot \left(\frac{\sum_k^4 Y_k(\cdot)}{4} - Y_1(\cdot) \right) \qquad (6)$$

Further, two additional constraints hold: $\tau_1 \geq 0$ and $\gamma^H \epsilon [0, 1]$. Redistribution transfers are paid in the first place to finance matching transfers. Additional funds may then be provided as lump sum transfer τ_1. The rich regions considers budget constraint

$$C_1Y_1(\cdot) + (b-c)\cdot\frac{Y_2(\cdot)-Y_1(\cdot)}{2} + c\cdot\left(\frac{\sum_k^4 Y_k(\cdot)}{4} - Y_1(\cdot)\right) - (1-\gamma^M)I_1 - T^M$$

The poor regions considers budget constraint

$$C_1Y_1(\cdot) + (b-c)\cdot\frac{Y_2(\cdot)-Y_1(\cdot)}{2} - (1-\gamma^M-\gamma^H)I_1 - T^M$$

Poor regions receive only a matching grant transfer from H government but no unconditional matching grant transfer at all. On the other hand, rich regions pay unconditional transfers depending on their GDP but do not receive any matching transfers from the high level. The high level can not impose taxes to provide matching transfers to the rich regions. Hence, we face an asymmetrical problem for poor and rich regions. High level and middle level governments utilities are considered correspondingly. The only difference is that the middle level takes into account the redistributive character of matching transfers from the high level:

$$W^M = \sum_i^2 U\left(Y_i + (b-c)\cdot\frac{Y_j-Y_i}{2} + c\cdot\left(\frac{\sum_k^4 Y_k}{4} - Y_i\right) - (1-\gamma_i^M)I_i^* - T_i^M\right)$$

Note that γ_i^H enters only indirectly through regional behavior in last step of the game. Similarly, the high level maximizes

$$W^H = \sum_i^4 U\left(Y_i + (b-c)\cdot\frac{Y_j-Y_i}{2} + c\cdot\left(\frac{\sum_k^4 Y_k}{4} - Y_i\right) - (1-\gamma_1^M)I_i^* - T_i^M\right)$$

Solving this game leads to

Proposition 4.4 *Assume that matching transfers from H can only be provided to poor and are financed by rich regions. Then,*

i) For a rich region, $\gamma^M > 0$ and $\gamma^H = 0$ and I_1^M is implemented which is below first best.

ii) For poor regions three cases can be distinguished.

For $c > \frac{\frac{b}{2}\rho_1}{\frac{\sum_k^4 Y_k}{4} - Y_1}$, $\gamma^H > 0$ and $\gamma^M = 0$ and I_1^H is implemented.

For $c < \frac{\frac{b}{2}\cdot\rho_1}{\frac{\sum_k^4 Y_k(\cdot)}{4} - Y_1(\cdot) + \frac{\rho_1}{2}}$, $\gamma^H > 0$, $\gamma^M > 0$ I_1^M is implemented.

Finally, for $\frac{\frac{b}{2}\rho_1}{\frac{\sum_k^4 Y_k}{4} - Y_1 + \frac{\rho_1}{2}} < c < \frac{\frac{b}{2}\rho_1}{\frac{\sum_k^4 Y_k}{4} - Y_1 + \frac{\rho_1}{2}}$, $\gamma^H > 0$, $\gamma^M > 0$ and $I_1^M \leq I_i \leq I_1^H$.

Proof i) Solving the maximization problem of the rich regions yields $I_2^* = \frac{\rho_2(4-2\cdot b-c)}{4\cdot(1-\gamma_1^M)}$. The maximization problem of the middle level government for the rich regions yields $\gamma_2^M = 1 - \frac{4-2\cdot b-c}{4-2c}$. This matching rate implements the regional investment target of the middle level government, $I_2^M = \rho_1 \cdot (1-\frac{c}{2}) < \rho_1$. The implemented level of investment is below first best.

ii) Solving the maximization problem of the poor region yields $I_1^* = \frac{\rho_1(1-\frac{b}{2})}{1-\gamma_1^H-\gamma_1^M}$. Similar to the approach in proposition 4.2., we derive reaction function $\gamma_1^M = 1 - \gamma_1^H - \frac{1-\frac{b}{2}}{1-\frac{c}{2}}$ for the M-government and $\gamma_1^H = 1 - \gamma_1^M - \left(1-\frac{b}{2}\right)$ for the H-government. Solving the simultaneous move game by plugging reaction functions into each other reveals again that there is no interior solution for this problem.

Two potential corner solutions remain to be checked given the restriction on parameters, $\gamma_i^M, \gamma_i^M \,\epsilon\, [0,1]$:

1. $\gamma_i^H = 0$: In this case $\gamma_1^M = 1 - \frac{1-\frac{b}{2}}{1-\frac{c}{4}}$. Plugging into $\gamma_1^H = 1 - \gamma_1^M - \left(1-\frac{b}{2}\right)$ yields $\gamma_i^H = \frac{1-\frac{b}{2}}{1-\frac{c}{4}} - \left(1-\frac{b}{2}\right) > 0$, which is a contradiction

2. $\gamma_i^M = 0$: Plugging into reaction function of H yields $\gamma_1^H = 1 - \left(1-\frac{b}{2}\right) = \frac{b}{2}$ This in reaction function of M yields $\gamma_i^M = \left(1-\frac{b}{2}\right) - \frac{1-\frac{b}{2}}{1-\frac{c}{2}} < 0$. The non zero constraint is binding, therefore, $\gamma_i^M = 0$. This is the unique Simultaenous Move Nash Equilibrium with $\gamma_1^H = \frac{b}{2}$ and $\gamma_i^M = 0$, a corner solution.. This holds for $\gamma_1^H \cdot I_1 \leq c \cdot \left(\frac{\sum_k^4 Y_k(\cdot)}{4} - Y_1(\cdot)\right)$ or $c > \frac{\frac{b}{2}\rho_1}{\frac{\sum_k^4 Y_k}{4} - Y_1 + \frac{\rho_1}{2}}$. In this case $\tau_i > 0$.

Besides this unrestricted solution with large c, we also have to consider the case where c is small. This distinction allows for two additional sub cases:

1. c small: holds for $\gamma_1^H < \gamma_1^{M*}$ and $\gamma_1^H \leq (1 - \frac{1-\frac{b}{2}}{1-\frac{c}{2}})$. In this case we know that $\gamma_1^M + \gamma_1^H = (1 - \frac{1-\frac{b}{2}}{1-\frac{c}{2}})$ and $I_1 = \rho_1 \cdot \left(1-\frac{c}{2}\right)$. The middle level government implements its suboptimal desired level of investment. This holds if $\gamma^H \cdot I_1 \geq (1-\frac{1-\frac{b}{2}}{1-\frac{c}{2}}) \cdot \rho_1 \cdot \left(1-\frac{c}{2}\right)$. Together this yields $\gamma^H \cdot I_1 \geq (1 - \frac{1-\frac{b}{2}}{1-\frac{c}{2}}) \cdot \rho_1 \cdot \left(1-\frac{c}{2}\right) > c \cdot \left(\frac{\sum_k^4 Y_k(\cdot)}{4} - Y_1(\cdot)\right)$. This simplifies to $c < \frac{\frac{b}{2}\cdot\rho_1}{\frac{\sum_k^4 Y_k(\cdot)}{4} - Y_1(\cdot) + \frac{\rho_1}{2}}$.

2. intermediate values of c holds if c is between the two values of c determined above: $\frac{\frac{b}{2}\rho_1}{\frac{\sum_k^4 Y_k}{4} - Y_1 + \frac{\rho_1}{2}} < c < \frac{\frac{b}{2}\rho_1}{\frac{\sum_k^4 Y_k}{4} - Y_1}$.

■

For rich regions, the intuition is straightforward. The high level government does not dispose over funds to provide matching transfers for rich regions. The latter only contribute to the federal system at the high level by paying unconditional transfers depending on the value of c. Middle level governments still dispose over the necessary tax autonomy to finance matching transfers and can therefore implement their investment target for rich regions. Since middle level governments behave strategically, this does not assure first best.

As Figure (4.4) shows, three cases can be distinguished for poor regions.

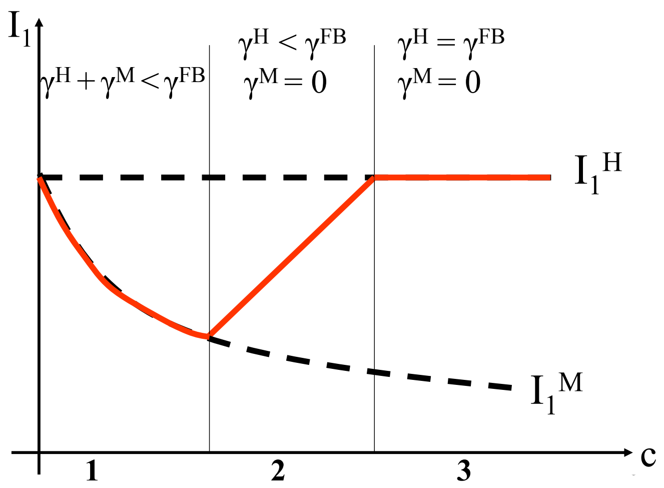

Figure 3: Implemented level of investment for a poor region depending on c.

In range 3, c is large. The H-government disposes over sufficient funds to finance matching transfers which are required to assure its investment target for the poor, I_1^H. The high level can provides conditional investment transfers to poor regions until first best investment is implemented. Additional funds from the rich are then additionally made available to the poor in lump sum form by τ_1. As in Section 4.3. this leads to $\gamma^H > 0$ and $\gamma^M = 0$ since the investment target of the middle level for poor regions is below first best.

In range 2, c is at a level where it does not allow the H-government to implement its desired first best regional investment. However, if it provides all disposable redistribution funds to poor regions conditional on investment, it can still implement a level of regional investment which is above the target of the middle level. Therefore, also in this case the M-government does not provide any matching grants, $\gamma^M = 0$.

Only the high level government provides matching transfers but first best can not be implemented due to the restricted space for action at the high level. This results in $I_1^M < I_1 < I_1^H$.

Finally, in range 1, c is small. Funds disposable at the high level are too low to provide sufficient incentives to poor regions in order to raise their investment beyond the target of the M-government, I_i^M. Since the investment target of the H-government is still first best, it provides all its available funds conditional on investment. Therefore, $\gamma^H > 0$ and $\tau_1 = 0$. The middle level only provides matching grants to assure its own desired level of regional investment I_1^M. The implemented level of regional investment in poor regions is below first best although matching transfers are made available by the middle level as well as the high level. This result holds, since the scope of the high level is severly restricted by the low value of parameter c.

Coming back to the example of the EU, we can now explain why it provides exclusively conditional grants to poor regions: Supranational redistribution leads to unexpectedly high divergence between national and supranational conditionality. However, rather little redistribution power is attributed to EU bodies compared to overall GDP within the Union. This implies a low value of c in our model. In order to get as close as possible to its target, the EU provides all its disposable redistribution funds in terms of matching grants. This reasoning corresponds to range 2 or 3 in Figure (4.4).

This finding implies a further strategic, endogeneity in the model: The determination of parameter value c. Only if parameter c is low enough, national governments can assure their own suboptimal regional investment target. This explains why also poor national governments are so reluctant to delegate redistribution authority to EU-institutions, although this would allow them to attract additional funds. Therefore, too low redistribution in the EU does not only lead to a suboptimal distribution of resources in the Union, as implied by standard theory, but also leads to structural underinvestment - particularly by rich regions as Proposition 4.3. suggests. This reasoning corresponds to range 3 in Figure (4.4). [4]

[4]The reason why in reality we still observe conditional grants on the national level can be explained by moral hazard problems, higher level spillover-effects, or the financing mechanism behind matching grants as discussed in Section 4.3.

5 Conclusion

Against the common assumption in economics theory, federal systems are often complex and are organized beyond more than two tiers of government. This paper analyzes how disincentives, optimal corrective policies, and implemented levels of regional investment change if redistribution is mutually organized by two distinct tiers of government. Our model reveals that particularly the middle level government, which until now has been mostly ignored by the theory of federalism, may behave strategic and give incentives for its regions to deviate from optimal behavior. To show this, we analyze federal redistribution in the presence of vertical externalities of regional public investment.

In the benchmark case with only one central government, regions under-invest without further central intervention. Consequently, federal redistribution intrinsically requires corrective matching grant payments towards both rich and poor regions to achieve its redistribution objective and first best regional investment at the same time.

A more sophisticated federal system with three tiers of government allows investigating the impact of mutual redistribution by two higher level authorities. We find that more redistribution organized on the highest level reduces investment targets of both regional and middle level governments. In order to investigate optimal corrective policies by the two higher levels, we distinguish three cases. First, we imagine a federal structure with federal, state, and regional governments where both federal and state governments dispose over tax autonomy. If matching transfers are financed type specific, the tax system does not generate additional incentive effects. In this case only disincentive effects from federal redistribution are active. Since the high level government disposes over tax instruments it can restore its own first best regional investment target by providing a sufficient amount of matching transfers besides its redistributive lump sum funds. In the unique Simultaneous Move Nash Equilibrium M-governments only contribute to unconditional redistribution by a share $(b - c)$, while conditional transfers are exclusively provided by the H-government.

We generalize this setting by a general tax rule to finance corrective matching grants. This introduces an additional tax effect. Middle level governments balance the positive inventive from the tax mechanism to the negative effect of the redistribution system as analyzed in case one. Both middle level and high level governments provide conditional transfers to implement first best investment at the regional level.

These two settings are most close to what we observe in the US.

Finally, we investigate the case where the H-government can not raise taxes to provide matching transfers. Again we introduce a type specific tax system to abstract from additional tax effects. The H-government can only provide redistribution funds conditional on investment conditional on its redistribution autonomy, c. Rich regions only receive suboptimal matching grant payments from the national government. Depending on the value of parameter c, the implemented level of investment in poor regions may either correspond to the nationally desired level, to the first best level desired by the supranational government or lie in-between these borders.

Among other things, the model nicely explains why the European Union exclusively provides conditional redistribution transfers. In this paper we only concentrated on mechanisms arising within a redistribution system. Our results highlight why national governments are so reluctant to convey more redistribution authority to EU bodies corresponding to a low parameter value of c in our model. As soon as a higher government level with some decision power on redistribution is installed, middle level governments want their own regions to strategically underinvest. If the EU level does not dispose over enough autonomy, underinvestment may occur particularly in rich regions.

6 References

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, 9, 631649.

Bergvall D., C. Charbit, D.-J. Kraan, and O. Merk (2006) ”Intergovernmental Transfers and Decentralised Public Spending”, Public Governance and Territorial Development Directorate O.E.C.D., COM/CTPA/ECO/GOV/WP(2006)/3.

Bird, R. M. and M. Smart (2002) Intergovernmental Fiscal Transfers: International Lessons for Developing Countries, World Development 30, 899912.

Bordignon, M., P. Manasse, and G. Tabellini (2001) ”Optimal Regional Redistribution under Asymmetric Information”, American Economic Review, 91, 709-723.

Cremer, H. and P. Pestieau (1996) ”Distributive implications of European integration” European Economic Review, Vol. 40, 747-757.

Cremer, H. and P. Pestieau (1997) ”Income Redistribution in an Economic Union: The Trade Off Between Inter- and Intra-National Redistribution”, International Tax and Public Finance, Vol.4, 325335.

Cremer, J. and T.R. Palfrey (2002) ”An Equilibrium Model of Federalism with Externalities”, mimeo, University of Toulouse, California Institute of Technology

Dahlby, B (1996) ”Fiscal Externalities and the Design of Intergovernmental Grants”, International Tax and Public Finance, 3, 397-412.

Fenge, R. and M. Wrede (2004) ”EU Regional Policy: Vertical Fiscal Externalities and Matching Grants” mimeo, ifo Institute Munich.

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 (2005) ”Interregional Redistribution and Budget Institutions under Asymmetric Information”, mimeo, University of Munich, CESifo.

Inman, R. (1988) ”Federal Assistance and Local Services in the United States: The Evolution of a New Federalist Fiscal Order”, In H. Rosen, (eds.), Fiscal Federalism: Quantitative Studies, Chicago, University of Chicago Press, 3377.

Johnson, W. R. (1988) ”Income Redistribution in a Federal System”, American Economic Review, Vol. 78, No. 3, 570-573.

Matheson, T. (2005) ”Does Fiscal Redistribution Discourage Local Public Investment? Evidence From Transitional Russia”, Economics of Transition, Vol 13, No. 1, 139-162.

Oates, W.E. (1972): ”Fiscal Federalism”; New York: Harcourt, Brace, Jovanovich.

Persson, T. and G. Tabellini, (1996) ”Federal Fiscal Constitutions: Risk Sharing and Redistribution”, Journal of Political Economy, 104(5), 979-1009.

PWC (1999): ”Local Government Grant Distribution - An International Comparative Study”; PricewaterhouseCoopers; London.

Seitz, H., T. Fester, A. Kappeler, and M. Thum, (2005) ”Öffentliche Infrastruktur und kommunale Finanzen”, IFO-Dresden Studien, Band 37.

Wildasin, D.E. (1997) Externalities and Bailouts: Hard and Soft Budget Constraints in Intergovernmental Fiscal Relations, mimeo.