2014

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INTERNATIONAL CENTER FOR PUBLIC POLICY

International Center for Public Policy
Working Paper 14-04
January 2014

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Does Competition for Capital Discipline Governments? The Role of Fiscal Equalization

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This version: December 2012

Abstract

This paper examines how a fiscal equalization system affects the disciplining effect of competition for capital among heterogeneous regions in a decentralized economy. I build a model in which regions that are heterogeneous in initial endowments try to attract capital by competing public input that enhances the productivity of capital; meanwhile, a fiscal equalization system is imposed by the central government to reduce regional disparities in fiscal capacity. The key prediction, borne out in data from the German equalization system, is that while competition for capital strengthens discipline in the well-endowed regions, it weakens discipline in the poorly-endowed regions. However, a conventional equalization transfer scheme, common to many countries, can be effective in correcting the distortion driven by the heterogeneity of initial endowments across competing regions.

Keywords: Fiscal competition; disciplining effect; fiscal equalization; system GMM
JEL Classifications: H54, H72, H73, H77, C23

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1 Introduction

Competition for capital is known to have important disciplining effect on governments' expenditure behavior. This is so because the fear of capital outflows motivates governments to invest more in public input, such as infrastructure that enhances the productivity of capital, while spending less on non-productive public consumption (Keen and Marchand, 1997; Qian and Roland, 1998; Schulze and Ursprung, 1999; Sørensen, 2004; Egger and Falkinger, 2006).[1] The standard model in the fiscal competition literature relies on the assumption of homogeneous competing regions. Most authors agree on a symmetric equilibrium in which regions converge to the same policies; thus, competition for capital implies a uniform disciplining effect on all regions.[2] Cai and Treisman (2005, henceforth C&T) question the validity of this homogeneity assumption and argue that competition for capital in a decentralized economy with heterogeneous regions in initial endowments leads to a "one-sided" disciplining effect. That is, only well-endowed regions end up with more public input; poorly-endowed regions, in anticipation of losing the game, will simply give up on competition and turn to more non-productive public consumption.[3]

Despite a more reality-relevant model, C&T's analysis is restricted to the situation in which decentralization is implemented without any intervention from the central government. As a stylized feature of many decentralized economies, however, a system of fiscal equaliza-

[1] Whether this disciplining effect of competition for capital is harmful or beneficial is still under debate. Opponents argue that the disciplining effect is gained at the expense of social welfare and environmental standards (Cumberland, 1981; Rom et al., 1998; Wilson, 1999; Keen and Kotsogiannis, 2004).

[2] See Dembour (2008) for a survey of literature on competitive location policies. For surveys of the tax competition literature in general, see Wilson (1999) and Wilson and Wildasin (2004).

[3] This observation has strong policy implications for the current ongoing decentralization process in many countries in which asymmetries in natural resources, human capital, or infrastructure are quite common across different regions. Decentralization reforms would therefore give rise to divergent expenditure policies by regional governments in these countries; with initially better endowed regions emphasizing more productive expenditure policies while initially less well-endowed regions doing the opposite. Consequently, initial regional disparity is anticipated to get larger in heterogeneously endowed countries. Empirically, C&T provide suggestive evidence from Russia's market liberalization reform that regions with better initial endowments tend to spend proportionally more on infrastructure and develop more effective market institutions than regions with poor initial endowments. In the case of China, Zhang (2006) shows that initial heterogeneous endowments relating to economic structures and fiscal burdens help explain how fiscal decentralization has favored initially better-endowed regions and exacerbated existing regional gaps.

tion similar to those existing in many countries, such as Canada, Germany or Switzerland, is observed and is deemed to be a key policy instrument in the hands of the central government for tackling existing disparities among poorly- and well-endowed regions. In this paper, I extend the basic model of C&T to include a common form of equalization transfers that distributes funds to regions on the basis of the representative tax system (RTS) methodology,[4] show that the system of equalization sets disincentives for regional governments to raise investment in public input, and argue that this finding has important implications for correcting the above "one-sided" disciplining effect within the equalization system.

After developing the model, I test it empirically with data from Germany for the following three reasons. First, tax legislation is highly centralized at the federal level in Germany. Tax rates are, therefore, uniform across states (Länder), which fits well with the model assumption that "tax rates are fixed at the federal level".[5] Second, the full implementation of the complex equalization system, which combines both "horizontal" redistribution of tax revenues between rich and poor states and "vertical" transfers from the federal government, implies varied extents of equalization among states with different fiscal capacities–a feature that is important for the empirical identification. Third, the recent reunification of East and West Germany provides a "natural" classification of the poorly-endowed and well-endowed regions, which is essential to empirically test the asymmetric policy responses of initially heterogeneous regions as a result of competition for capital.

The contribution of this paper is twofold. Theoretically, by incorporating fiscal equalization program, which typically operates in many federal countries, into C&T's original model, this paper captures a relatively larger aspect of the decentralized economies and provides further insight into the disciplining effect of competition for capital among heterogeneous regions. In particular, the theory reveals that an equalization scheme imposes an implicit tax on a region's revenue that is generated by its public input policy. Thus, if the equal-

[4]This approach, similar to the ones employed in Smart (1998, 2007) and Köthenbürger (2002), is discussed in the next section of this paper

[5]See the model setup in the next section of this paper.

ization scheme initially confronts well-endowed regions with a higher marginal tax rate on any additional revenues produced by investment in public input relative to initially poorly-endowed regions, then well-endowed regions have a relatively lower incentive to expand the tax base by choosing higher levels of public input. As a consequence, the original divergent expenditure policies on public input between poorly- and well-endowed regions, driven by the heterogeneity of initial endowments, will be mitigated by the asymmetric incentives of the two types of regions in response to the equalization system.

Empirically, I find strong evidence supporting the theoretical predictions. Using a panel dataset of German states covering the period between 1995-2007, my estimation results confirm C&T's original hypothesis that initially well-endowed states (i.e., West German states) tend to spend a higher proportion on public input than their poorly-endowed counterparts (i.e., East German states). Further, my estimation that identifies the role of the equalization system suggests a negative impact of a state's own marginal tax rate of equalization and a positive impact of the competing states' marginal tax rate of equalization, on the state's expenditure on public input. This result validates the theoretical implication that the equalization system can be used to serve as a mechanism to correct the "one-sided" disciplining effect driven by competition among heterogeneous regions.

1.1 Review of the Related Literature

Since equalization systems distribute fiscal transfers to regions in a way that correlates inversely with their fiscal capacities, and these fiscal capacities are largely affected by strategic interactions among competing regions, a number of scholars have observed that fiscal equalization may induce significant incentive effects on the taxing policy of regional governments and eventually alter the equilibrium outcome of tax competition. As initially outlined by Boadway and Flatters (1982) and later formally modeled by several others, such as Smart (1998), Köthenbürger (2002, 2004, 2005), and Bucovetsky and Smart (2006), fiscal equalization schemes are shown to be able to limit tax competition and improve efficiency. This is

because when a region attempts to attract capital from other regions by cutting tax rates, it increases its own tax base relative to the national average, which simultaneously reduces the region's entitlement for higher grants. Consequently, the fiscal equalization system imposes incentives for regional governments to raise their tax rates.[6] More recently, Büttner (2006), Smart (2007) and Egger et al. (2010) examine the equalization system of Canada and Germany and provide supporting evidence concerning the theoretical implications of the incentive effect of fiscal equalization on regional governments' tax policies.

Although there are a number of studies on how fiscal equalization schemes can correct for the inefficient outcomes of tax competition, the literature on the potential role of fiscal equalization in disciplining expenditure policies of regional governments is scarce. Assuming homogeneity among all the competing regions, Hauptmeier (2009) and Breuillé et al. (2010) investigate the effects of equalization transfers on the mix of local spending and conclude that the systematic bias of public spending toward an over-provision of public input– as pointed out in Keen and Marchand (1997)– is indeed alleviated via an equalization transfers system. However, their framework does not allow them to explore how equalization transfers may affect the asymmetric choice of expenditure policies across heterogeneous regions, which is the main focus of this paper. More closely related to my analysis, Ivanyna (2010) analyzes the role of fiscal transfers as an instrument in restraining the malevolent behavior of local bureaucrats. He finds that when there is initial heterogeneity in productivity, subsidizing private capital investments in poorly-endowed regions directly leads to increased levels of public spending in all regions and to lower levels of corruption. However, the main focus of Ivanya's work differs from mine in one significant way. Ivanyna introduces a benevolent social planner in the model, and then discusses the ideal design of fiscal transfers system so that the malevolent behavior of local bureaucrats can be restrained in every region. Instead, I directly introduce an equalization transfers scheme, similar to that used in many countries,

[6] Hindriks et al. (2008) argue that the equalization system's correction for inefficiency of tax competition does not always hold in the presence of both tools of taxes and public investment. They show that equalization is more likely to affect public investment choices but not equilibrium taxes because the marginal retention rate of tax revenue decreases simultaneously with equalization which sets a disincentive for tax-raising efforts.

into the inter-regional competition model and explore its potential impact on the asymmetric expenditure policies chosen by heterogeneous regions from a positive perspective.

The rest of the paper is organized as follows. Section 2 develops the theoretical model based on C&T's original setup, and derives testable empirical implications. Section 3 gives a brief introduction of Germany's state equalization system. Section 4 sets up the empirical methodology and discusses the data. Section 5 presents the empirical results. Finally, section 6 concludes.

2 The Model

2.1 Setup of the model

The basic structure of the model is based on C&T. I introduce a common form of an equalization transfer system to their original model and analyze its implications for the disciplining effect of competition for capital among heterogeneous regions.

Consider an economy consisting of $N + M$ regions, indexed by i. Of these regions, there are only two types of regions which differ in their initial endowments.[7] N denotes well-endowed regions, and M denotes poorly-endowed regions. Since initial endowments affect the marginal productivity of capital locally invested, other things being equal, capital is more productive in N than in M.

In each region a numeraire output is produced, and this output can either be used as private consumption or government consumption. Specifically, the aggregate production function is given by the standard Cobb-Douglas form

$$F_i(K_i, I_i) = A_i K_i^{\alpha} I_i^{\beta} \tag{1}$$

[7]Endowment refers to those factors that affect the productivity of a region, including stocks of natural resources, human capital or infrastructure, etc.

where $\alpha > 0, \beta > 0, \alpha + \beta < 1$ and $A_i > 0$,[8] K_i is the amount of private capital invested in region i and I_i is the amount of public input provided by the regional government that enhances the productivity of private capital; A_i is the region-specific technology parameter that reflects the effect of initial endowments on productivity. It is further assumed that $A_i = A_n$ represents the technology in well-endowed regions, $A_i = A_m$ the technology in poorly-endowed regions, and so $A_n > A_m$.

Since capital is assumed to be perfectly mobile across regions, the market clearing condition implies an allocation of capital across regions such that its net return in all regions is equalized to the given economy-wide net return to capital (r), that is

$$(1-t)\frac{\partial F_i}{\partial K_i} = r \tag{2}$$

where $\frac{\partial F_i}{\partial K_i}$ denotes the marginal product of capital; t is the ad valorem tax rate on output in region i and it is assumed to be fixed and coordinated by the central government for all i.[9]. With equation (1), I can solve (2) for the capital allocated in region i, to obtain $K_i = (\frac{1}{r}(1-t)\alpha A_i I_i^{\beta})^{\frac{1}{1-\alpha}}$. As indicated, capital flows to region i are determined by both exogenous initial endowments (A_i) and endogenous public input (I_i).

The objective of each region is to maximize the utility of a representative household, and this utility depends on the consumption of some combination of private goods and residential public goods[10]

$$U_i = (1-t)F_i + \lambda g_i \tag{3}$$

where $(1-t)F_i$ represents the disposable private goods and g_i represents the residential

[8]For analytical convenience, other fixed factors such as land or labor are normalized to unity and so not included in the production function. The assumption that $\alpha + \beta < 1$, therefore, reflects this point.

[9]This assumption presents the advantage of focusing exclusively on the strategic interactions of public input among regional governments. Indeed, in their extension analysis, C&T show that incorporating endogenous tax rate competition is likely to strengthen the main results of the analysis.

[10]Residential public goods refer to those public goods that are directly consumed by the residents in the economy and do not enhance the productivity of private capital in any respect. As a matter of fact, equation (3) can also be interpreted as the objective function of a partially self-interested government, in which case g_i stands for incumbent officials' consumption of budget funds (C&T, p820).

public goods provided by regional governments; $\lambda > 0$ measures household's preference for residential public goods relative to private goods. Regional governments use their output tax revenues (tF_i) and transfers (T_i) received from the central government to finance the residential public good (g_i) and the public input provision (I_i). The budget constraint of each region is $I_i + g_i = tF_i + T_i$.[11]

Consider now the newly introduced transfer system. As noted in the introductory section, the system I assume here is a common form of an equalization transfer system that distributes funds to regions on the basis of the representative tax system (RTS) methodology. More specifically, it sets the per capita transfer received or contributed for each region equal to the difference between its capacity and the national average fiscal capacity, multiplied by the national average effective tax rate. Algebraically, region i's total transfers received or contributed are given by

$$T_i = \upsilon_i \bar{t}\left(\frac{\sum_i F_i}{\sum_i p_i} - \frac{F_i}{p_i}\right)p_i \tag{4}$$

where p_i is the population size in region i; $\frac{\sum_i F_i}{\sum_i p_i}$ represents the per capita national average tax base; $\frac{F_i}{p_i}$ is region i's per capita tax base; $\bar{t}$ is the national average tax rate. Tax rates are exogenously fixed across all regions, so $\bar{t} = t$. The term in brackets measures the deviation of a region's per capita tax base from the national average. A positive value indicates the region has below-average fiscal capacity and, thus, is eligible for transfers. For negative values, the region has to pay a contribution or negative transfer. The policy parameter, $0 \leqslant \upsilon_i \leqslant 1$, in the equalization formula determines the extent to which the deviations of region i's fiscal capacity are equalized.[12] Summing up, the budget constraint of region i can be rewritten as

$$I_i + g_i = tF_i + \upsilon_i \bar{t}\left(\frac{\sum_i F_i}{\sum_i p_i} - \frac{F_i}{p_i}\right)p_i \tag{5}$$

[11] Note that $T_i = 0$ in C&T's original model. I will show how this new element leads to a different equilibrium in the latter part of this section.

[12] Typically, the policy parameter υ_i would be the same for all regions. However, there are countries that allow more equalization in certain economically disadvantaged regions. The pool of funds may also be allocated in a manner not proportional with a constant υ_i but instead to fill the gap of the poorer regions with priority.

I examine a game in which all regional governments simultaneously choose the levels of I_i, and then the investors make the decisions on where to invest. I then compare the equilibriums for two cases: with and without the equalization scheme.

2.2 Equilibrium

The problem of each region's government is to choose its public input (I_i) independently so as to maximize its objective function (3), subject to its budget constraint (5). The resulting equilibrium of investments on public input and capital allocation are given as follows, while the mathematical induction can be found in the Appendix A.

$$I_i^* = (\frac{\beta}{\lambda})^{\frac{1-\alpha}{1-\alpha-\beta}} (\frac{\alpha(1-t)}{r})^{\frac{\alpha}{1-\alpha-\beta}} A_i^{\frac{1}{1-\alpha-\beta}} \tau_i^{\frac{1-\alpha}{1-\alpha-\beta}} \tag{6}$$

$$K_i^* = (\frac{\beta}{\lambda})^{\frac{\beta}{1-\alpha-\beta}} (\frac{\alpha(1-t)}{r})^{\frac{1-\alpha-\beta+\alpha\beta}{(1-\alpha-\beta)(1-\alpha)}} A_i^{\frac{1}{1-\alpha-\beta}} \tau_i^{\frac{\beta}{1-\alpha-\beta}} \tag{7}$$

where $\tau_i \equiv (1-t+\lambda t)\frac{1}{1-\alpha} + (\frac{p_i}{\sum_i p_i} - \frac{1}{1-\alpha})\lambda v_i t > 0$, with the properties that $\frac{\partial \tau_i}{\partial v_i} < 0$, $\frac{\partial \tau_i}{\partial p_i} > 0$. Equation (6) immediately gives the following result.

Proposition 1. *In equilibrium, a region's investments on public input I_i^* is increasing in both A_i and τ_i.*

Considering the relative investments on public input and capital allocation in both well-endowed and poorly-endowed regions by taking the ratios of their optimal public input levels and capital received respectively.

$$\frac{I_n^*}{I_m^*} = (\frac{A_n}{A_m})^{\frac{1}{1-\alpha-\beta}} (\frac{\tau_n}{\tau_m})^{\frac{1-\alpha}{1-\alpha-\beta}} \tag{8}$$

$$\frac{K_n^*}{K_m^*} = (\frac{A_n}{A_m})^{\frac{1}{1-\alpha-\beta}} (\frac{\tau_n}{\tau_m})^{\frac{\beta}{1-\alpha-\beta}} \tag{9}$$

With these expressions of the equilibrium, I can analyze two cases:

(i) *Equilibrium without equalization.* In this case, I assume the absence of the equalization system from the model, which by definition, reduces the model to the original C&T model. Mathematically, this is equivalent to solving the current model in an extreme case that $\upsilon_i = 0$, which in turn gives the condition $\tau_n = \tau_m$. Equations (8) and (9) are then reduced to $\frac{I_n^*}{I_m^*} = \frac{K_n^*}{K_m^*} = (\frac{A_n}{A_m})^{\frac{1}{1-\alpha-\beta}}$— the original equilibrium of C&T. Clearly, the greater is the asymmetry in initial endowments $\frac{A_n}{A_m}$, the larger is the gap of capital allocation $\frac{K_n^*}{K_m^*}$ and optimal investments on public input $\frac{I_n^*}{I_m^*}$ between the two types of regions. Since the total stock of capital is fixed in the economy, i.e., $NK_n^* + MK_m^* = \bar{K}$, an increase of $\frac{A_n}{A_m}$ must lead to an increase in K_n^* and a decrease in K_m^* in order to ensure an increase of $\frac{K_n^*}{K_m^*}$. Meanwhile, the decision rule for investments in public input in equation (15) reveals a strictly increasing function of $I_i(K_i, A_i)$ in both K_i and A_i.[13] This implies that the increase of $\frac{A_n}{A_m}$ will be converted to an increase in I_n^* and a decrease in I_m^*. Thus, the heterogeneity of initial endowments leads to the so called "one-sided" disciplining effect as described in C&T.

(ii) *Equilibrium with equalization.* In this case, the term, $\frac{\tau_n}{\tau_m} \neq 0$, will be present on the RHS of equations (8) and (9). It is, therefore, straightforward to expect that if an increase of $\frac{A_n}{A_m}$ is offset by a decrease of $\frac{\tau_n}{\tau_m}$, then the detected "one-sided" disciplining effect can be corrected within the model. The following proposition characterizing the role of the equalization transfers can be stated.

Proposition 2. *Other things being equal, as* $\frac{\tau_n}{\tau_m}$ *decreases,* $\frac{K_n^*}{K_m^*}$ *and (so)* $\frac{I_n^*}{I_m^*}$ *becomes smaller.*

Since τ_i is a decreasing function of υ_i, and an increasing function of p_i, this proposition suggests that other things being equal, if (a) the equalization transfer scheme has the property that the equalization degree in well-endowed regions is higher than the degree in poorly-endowed regions, i.e., $\upsilon_n > \upsilon_m$; or (b) poorly-endowed regions are more populated regions

[13] See Appendix for details.

relative to well-endowed regions, i.e., $p_n < p_m$, then the divergent expenditure policies caused by the heterogeneity of initial endowments can be corrected via the equalization system.[14]

2.3 Interpretation

The interpretation for the role of equalization system revealed by Proposition 2 can be captured by the concept of the marginal tax rate of equalization system (MTRE). This concept is defined as the fraction of one unit of additional tax revenue in a region that flows out of the region due to the functioning of the system (Baretti et al., 2002).[15]

More formally, let us rewrite the budget constraint (5) in a way that total tax revenue of region i can be grouped into a single term, $I_i + g_i = (1 + \upsilon_i \frac{p_i}{\sum_i p_i} - \upsilon_i) tF_i + \upsilon_i t \frac{p_i \sum_{j \neq i} F_j}{\sum_i p_i}$. Now consider that the region experiences one unit increase in total tax revenue tF_i, due to the mechanism of equalization transfer system, the total net gain of region i amounts to $(1+\upsilon_i \frac{p_i}{\sum_i p_i} - \upsilon_i)$. Thus, the fraction that flows out of the region, and so the marginal tax rate of equalization system for region i is, $MTRE_i = (1 - \frac{p_i}{\sum_i p_i})\upsilon_i$.[16] It clearly indicates that a larger υ_i or smaller p_i leads to a higher MTRE in the region. Since υ_i captures the extent to which the gap between the region's own fiscal capacity and the national average is equalized, it has a direct effect on the fraction that will flow out of the region. On the other hand, a smaller population size p_i implies a smaller share of total nationwide tax revenue in the equalization system, which in turn means a larger outflow for the additional increment of tax revenue. Therefore, the mechanism implied by Proposition 2 suggests a larger equalization degree or a smaller population size in well-endowed regions is equivalent to a higher value of MTRE in these regions. More generally, incorporating the MTRE to Propositions 1-2 gives us the following implication for empirical tests.

[14] As a matter of fact, even if well-endowed regions are more populated regions relative to poorly-endowed regions, i.e., $p_n > p_m$, the equalization scheme with the feature that $\upsilon_n > \upsilon_m$ can still be used to correct for the divergent expenditure policies.

[15] Note that under an equalization transfer system, a higher fiscal capacity will reduce the region's transfers from the equalization system or increase its contributions.

[16] See Baretti et al. (2002) for a similar formula in calculating marginal tax rate of equalization transfers.

Testable Implication 1. *(i) In equilibrium, a region's investments on public input I_i^* is increasing in initial endowments A_i, but decreasing in marginal tax rate of equalization $MTRE_i$; (ii) other things being equal, an increase of $MTRE_i$ or a decrease of $MTRE_{-i}$ ($-i$ indexes the other type of regions rather than type i) will lead to a decrease of I_i^*.*

Intuitively, the MTRE captures the marginal tax rate on any additional tax revenues that are produced by investments on public input. A higher level of MTRE in a region implies a lower incentive for the region to expand the tax base by choosing higher level of public input investment in order to obtain more equalization transfers or contribute less equalization transfers. A higher level of MTRE in the competing regions, by contrast, would reduce the extent of strategic response of these regions to the home region's expenditure policy, which results in an increase of investments on public input in the home region.

Although, as we have just seen, both the policy parameter υ_i and population size p_i play an important role in the determination of the MTRE, the latter factor is simply not a feasible choice variable in the hands of the central government. From a policy perspective, it is indeed the parameter υ_i that is controlled by the central government that fundamentally shapes the role of the equalization system. Understanding this point and knowing the direction to which this policy parameter affects the behaviors of regional governments is essential for a better design of the equalization system. In particular, if the central government's objective is to achieve a more balancing outcome of regional expenditure policies on public input, it would be necessary for the central government to impose a higher equalization degree υ_i, and so a higher MTRE in well-endowed regions than in its poorly-endowed counterparts. Nevertheless, if the opposite is observed, then the initially divergent situation is more likely to be strengthened as a result of the introduction of the equalization system. It should therefore be the central government's attention to ensure the emergence of the former case by properly distributing the policy parameters υ_i in the design of the system, provided the "one-sided" disciplining effect caused by endowment heterogeneity is a matter of concern for

the central government.

3 Equalization Transfers in Germany

Germany is a federation of sixteen states (Länder), ten of which are from the former Federal Republic of Germany (West Germany) and the remaining five are from the former German Democratic Republic (East Germany). The City of Berlin, which was formerly split between East and West Germany but reunified in 1990, consists of the sixteenth state. The country's tax legislation is highly centralized and allocates virtually no direct autonomy to the states in determining either the tax base or the tax rates. The main sources of revenue are generated through corporate income, personal income and value added (VAT) taxes and are required by law to be shared among the federal, state and local governments. While the detailed sharing arrangement for VAT between the federal and state governments has changed frequently since the fiscal reform (of West Germany) in 1969, the federal share of VAT has stabilized at around 53%, leaving the state governments' share at around 45% in recent years (Hepp and von Hagen, 2012). The sharing of corporate income tax and personal income tax revenue has been historically stable over the past three decades. The revenue from corporate income tax is shared on a 50-50 basis between the federal and state governments, and 15% of the revenue from personal income tax is allocated to municipalities while the rests are split equally between the federal and state governments (each receiving 42.5%).

Since the revenue structure varies significantly across states, the revenue sharing system involves considerable redistribution among states. Beyond this effort, the country operates an extensive system of equalization transfers (*länderfinanzausgleich, LFA*) for the sixteen states with an explicitly defined objective to assure "uniform living standards throughout the territory of the federation".[17] The key elements of the system were introduced in the fiscal reform (of West Germany) in 1969. It was initially designed for the ten West German states (leaving out the former West-Berlin) until the five East German states and the new

[17] *Grundgesetz* (German Constitution), Articles 72 and 106.

united city of Berlin were integrated into the system in 1995. The LFA is based on article 107 of the German constitution and consists of a three-stage process. The first two stages are largely characterized by horizontal redistribution between "rich" and "poor" states while the last stage involves additional vertical grants from the federal government to "poor" states.

During the first stage (known as "VAT redistribution"), 25% of the state's share of total national VAT revenue is used for horizontal redistribution.[18] That is, any state where the fiscal capacity per capita[19] is less than 92% of the national average receives VAT transfers to bring it up to the level of 92% of the national average. If the total amount available for the VAT redistribution is not large enough, the transfers are scaled back proportionally. In contrast, if the total amount available is larger than what is needed, then the residuals are again redistributed among all states according to the state's population share.

During the second stage (known as "fiscal equalization among the states"), each state's relative status is determined by the ratio of the state's fiscal capacity to its fiscal need.[20] For those states having ratios greater than 100%, they contribute to the system; whereas for those states whose ratios are less than 100%, they receive additional transfers from the system. More specifically, for "receiving" states: if the ratio lies at the interval of (0%, 92%], then the gap between the ratio and 92% of the national average is fully closed by transfers, and the remaining difference between 92% and the national average is subsidized at 37.5%; if the original ratio lies at the interval of (92%, 100%], only 37.5% of the difference between the ratio and the national average is subsidized. In the case of the "contributing" states, the contribution rates follow a progressive schedule: if the ratio is in the interval of (100%, 101%], 15% of the difference between the ratio and the national average must be

[18]The remaining 75% of the state's share of total national VAT revenues is reallocated among all states according to the state's population share (equal per capita basis), and so it does not involve equalization function.

[19]Fiscal capacity considered at this stage includes all pure state taxes plus a state's share of corporate income tax and personal income tax.

[20]Fiscal capacity in this stage is calculated as the sum of state tax revenues, which includes the total VAT revenues received in the first stage, and 50% of the tax revenues of its municipalities. Fiscal need is simply the per capita average of all the states' fiscal capacity multiplied by the state's population. In order to account for the special financial needs of the city-states, populations in Berlin, Bremen and Hamburg are valued at 135% of their actual values.

contributed; if the ratio belongs to the interval of (101%, 110%], an additional 66% of its fiscal capacity above 101% of the national average is contributed; if the ratio is above 110%, another 80% of the part lies above 110% of the national average is contributed. Finally, the total contributions of the "contributing" states are raised or lowered by a factor to ensure that total contributions equal to the total transfers received.

During the third stage (known as "supplementary federal grants"), two types of vertical grants from the federal government are distributed. The first one (type I) provides additional grants to fill 90% of any remaining gap between poorer states' fiscal capacity and the national average. The second type of supplementary grants (type II) are general purpose grants which are paid to account for special needs such as special allocations to cover above-average administration costs.[21]

Even though the size of the above LFA system expanded considerably in 1995 when East German states and the new city state of Berlin entered the system (the so-called "Solidarity Part I"), it has operated with virtually unchanged arrangements since 1969. A new arrangement came into effect from 2005 onwards and will last until 2019 (the so-called "Solidarity Part II"). The new arrangements reformed numerous interconnected elements of the existing system, for example, replacing the current system of a replenishment rate of 100% by a relative replenishment system in the VAT redistribution stage (LFA, stage 1); changing the fiscal equalization among states (LFA, stage 2) from the graduated tariff to a steady and linear tariff, etc.[22] However, the basic structure and mechanisms of the system have not been changed. As an example, Figure 1 illustrates the resulting main differences of the second stage of the LFA system before and after 2005. The solid line captures the detailed arrangements of the second stage of the LFA system before 2005. The dashed line describes the new arrangements after (including) 2005. As shown, under the new system, if the ratio of a state's fiscal capacity to its fiscal need is less than 80%, the gap will be closed up to

[21]Since these are beyond the interest of this paper, they will not be discussed any further in this paper. For more information, see Brand (2006).

[22]See Losco (2006) and Werner (2008) for further discussion on the new arrangements of the LFA system in Germany after 2005.

75%; after that, the compensation rate declines linearly to a value of 70% when the ratio reaches 93%; finally, the compensation rate declines linearly again with a steeper slope to a value of 44% when the ratio approaches 100%. A similar tiered system is also applied to the "contributing states", triggering different contribution rates depending on the states' fiscal capacity—less than 107%, between 107% and 120%, or greater than 120% of the fiscal need (Bayern Staatsministerium der Finanzen, 2005).

Following the above detailed settings of the system, I calculate the marginal tax rate of equalization for all the states in the period covered. Table 1 reports the average values of the MTRE for each state,[23] separated by different historical periods. As shown, the magnitudes of the MTRE across states are determined by the two main factors, which I highlighted in subsection 2.3–equalization degree v_i and population size p_i. Larger degree of equalization or smaller population size results in larger MTRE. Since the German system imposes a relatively higher degree of equalization for the "receiving" states than the "contributing" states, it leads to the result that East German states, all of which are "receiving" states, having, on average, a higher value of MTRE than West German states, a large part of which are "contributing" states.[24] However, the 2005 reform reversed this situation moderately by reducing the MTRE in East German states while increasing the MTRE in some of West German states in the "Solidarity Part II" period (see Table 1).

4 Empirical Methodology and Data

The model in section 2 predicts that regional heterogeneity of initial endowments leads to divergent expenditure policies on public input, while a system of equalization can be effective in correcting this distortion. In this section, I discuss the empirical strategy with the objective

[23]The values reflect either the reduced amount that the "receiving" states would otherwise receive from the system or the additional amount that the "contributing" states have to contribute, given a one unit increase in its income tax revenue.

[24]This situation raises a caution message that the German system may has been designed and implemented in the opposite direction as opposed to the desirable direction suggested by the theoretical model for correcting the "one-sided" discipline effect.

of testing these predictions that are explicitly summarized in *Testable Implication* 1, using a panel dataset of sixteen German states from 1995 to 2007. As I outlined in the introduction, one of the main reasons in supporting the selection of Germany as my case study is that I aim to employ East and West German states as the classification of initially poorly- and well-endowed regions, which otherwise could be a quite challenging task.[25] Since East German states have only been fully integrated into the state fiscal equalization system since 1995, I use year 1995 as the starting period in my analysis.

4.1 Specification

4.1.1 The baseline specification

In order to identify the prediction revealed in *Testable Implication* 1(i), I estimate the following baseline dynamic specification

$$I_{it} = \rho I_{it-1} + \lambda west_i + \delta mtre_{it-1} + X_{it-1}\beta + \eta_i + tt_t + \varepsilon_{it} \tag{10}$$

to explore the impacts of a state's initial status of endowments and its MTRE on the state's expenditure on public input. In the specification, I_{it} is the dependent variable, which is defined as the share of public input expenditure in total budgetary expenditure of state i in year t. I_{it-1} is a one-period (timely) lagged dependent variable, which is included to account for the high degree of persistence in the government policies that is typically observed in the data (e.g., Foucault et al., 2008; Kappeler and Välilä, 2008; Ghinamo et al., 2010; Klemm and Van Parys, 2012). $west_i$ is a dummy variable for West German states, which takes the value of 1 if state i belongs to West German states and 0 otherwise. This variable captures

[25] In the theoretical model, I clearly defined initially poorly-endowed regions as those regions that have lower output productivity, while initially well-endowed regions refer to those regions having higher output productivity. Since the large productivity gap between East Germany and West Germany has been well documented in the literature (e.g., Barrell and Te Velde, 2000; Burda and Hunt, 2001; Czarnitzki, 2005), my classification should be viewed to make a lot of economic sense. For instance, the aggregate productivity (measured by GDP per employee) in East Germany reached only 35% of the West Germany level in 1991 (Czarnitzki, 2005).

my classification of initially well- and poorly-endowed regions. $mtre_{it-1}$ is the marginal tax rate of the equalization system of state i in year $t-1$, which reflects the marginal tax rate on any additional tax revenues produced by investments on public input. It is lagged by one period to avoid the potential endogeneity issue of this variable. Furthermore, the specification includes state fixed effects (η_i) to control for unexplained heterogeneity across states that are constant over time and also a linear time trend (tt_t).[26]

As control variables X_{it-1} I seek to capture the general economic, fiscal, demographic, and political factors of significance in determining public input expenditure. This leads to the inclusion of real GDP per capita, openness, budget surplus, public debt, and population density. Real GDP per capita serves as a measure of the income level, as higher incomes are generally related to stronger demand for purely public services. Openness, which is calculated as the ratio of total trades (import plus export) to GDP, aims to capture the exposure of a state to trade and competition for capital. Following the studies by Mehrotra and Välilä (2006) and Kappeler and Välilä (2008), the short- and long-term fiscal environment is captured by the budget surplus of the state government and its public debt respectively. Both are measured in relative to GDP and have been shown to be significant in the determination of public investment in the literature. Population density serves as the needs for and cost of public input networks that differ between densely and sparsely populated regions (Kappeler and Välilä, 2008). I also include a set of political variables capturing the effects of elections and political preferences. These include a dummy variable for an election year, which takes the value 1 for each election year of the state and 0 otherwise; a dummy variable for partisan affiliation, which takes the value 1 if the state government in power in that year belongs to social-democratic party and 0 otherwise. Finally, all control variables are lagged by one period to avoid any bias arising from the possible joint determination of these variables and the dependent variable.

[26] The inclusion of state fixed effects also helps dealing with endogeneity that may arise from time invariant omitted variables.

4.1.2 Regional interactions

Testable Implication 1(ii) reveals that a state's expenditure on public input reacts positively to its competing states' MTRE. This correlation is obtained under the regional competition framework, which, by its nature, implies another positively strategic interaction between a state's public input expenditure and its competing states' public input expenditure. Thus, these properties result in the inclusion of the spatially lagged dependent variable and the spatially lagged of MTRE in the competing states to specification (10), which is also known as a dynamic spatial lag specification in the most general form of

$$I_{it} = \rho I_{it-1} + \sum_{j \neq i} \theta_{ij} I_{jt} + \lambda west_i + \delta mtre_{it-1} + \sum_{j \neq i} \psi_{ij} mtre_{jt-1} + X_{it-1}\beta + \eta_i + tt_t + \varepsilon_{it} \quad (11)$$

where j denotes all the competing states of state i. Since the focus is on the competition between the two types of states with heterogeneity in initial endowments, j represents the opposite type of state of state i. More specifically, if state i belongs to initially poorly-endowed states (i.e., East German states), then state j represents all initially well-endowed states (i.e., West German states); vice versus. However, this model cannot be estimated as it stands, as there are too many parameters (θ_{ij} and ψ_{ij}) to be estimated. The usual method adopted in spatial econometrics to address this issue is to estimate the following

$$I_{it} = \rho I_{it-1} + \theta I_{-it} + \lambda west_i + \delta mtre_{it-1} + \psi mtre_{-it-1} + X_{it-1}\beta + \eta_i + tt_t + \varepsilon_{it} \quad (12)$$

where I_{-it} and $mtre_{-it-1}$ are the weighted average of state j's public input expenditure and MTRE respectively, i.e.

$$\begin{cases} I_{-it} = \sum_{j \neq i} w_{ij} I_{jt} \\ mtre_{-it-1} = \sum_{j \neq i} w_{ij} mtre_{jt-1} \end{cases} \quad (13)$$

and w_{ij} are exogenously chosen weights, normalized so that $\sum_{j \neq i} w_{ij} = 1$.

An important decision concerns the choice of the weights. As emphasized above, the spatial interaction in this analysis is between initially poorly- and well-endowed states, which renders the use of geographic criteria in creating the weighting matrices infeasible.[27] Instead, I consider the following three possible weighting schemes that are proposed by Devereux et al. (2008). The first one (denoted as "weight I"), which serves as a benchmark, is very simple; weights are assumed to be uniform, i.e. $w_{ij} = \frac{1}{n_j}$, where n_j is the number of states classified as state j.[28] An alternative weighing scheme (denoted as "weight II") takes into account the relative wealth level of each state j. The typical element of the weights is, $w_{ij} = \frac{y_{jt}}{\sum_{j=1}^{n_j} y_{jt}}$, where y_{jt} denotes real GDP per capita of state j in year t. A final weighing scheme (denoted as "weight III") is intended to capture the relative extent of competition of each state j. The typical element of the weights is, $w_{ij} = \frac{e_{jt}}{\sum_{j=1}^{n_j} e_{jt}}$, where e_{jt} denotes openness of state j in year t. These latter two methods present a better approximation of the relative wealth levels and exposure to competition of the two types of regions involved in the competition, and serve as good candidates for robustness checks. It should be noted that I also relax the restriction that the competition is only conducted among initially poorly- and well-endowed states in order to examine the spatial interactions among all the states. This analysis and the associated results are discussed in detail later.

[27] In the standard practice of the spatial econometrics literature, a common assumption is the geographically close jurisdictions interact more strongly. This leads to the use of two common methods in defining the weights. The first one is based on a contiguity matrix, where the value 1 is assigned if two jurisdictions share the same border and 0 otherwise. An alternative is to use the inverse distances of two jurisdictions as weights (e.g., Foucault et al., 2008; Ghinamo et al., 2010; Jacobs et al., 2010; Klemm and Van Parys, 2012). Since the neighbors of a state may not be in the opposite type of this state at the same time, so the contiguity method may not coincide with my primary objective to explore the competition among initially poorly- and well-endowed states. Similarly, the inverse distance method is not employed due to the fact that geographically closer states of a state may be those states of the same type of this state, which again does not identify my theoretical question. However, these two methods are employed later in this study to test the robustness of the results by relaxing the assumption that the competition is only conducted among two types of regions.

[28] More specifically, if state j is initially well-endowed states (i.e., West German states), then n_j equals ten, which is the ten West German states; if state j is initially poorly-endowed states (i.e., East German states), then n_j equals 6, which is the five East German states plus the new united city of Berlin.

4.2 Estimation

In order to estimate specifications (10) and (12) unbiasedly and efficiently, two critical endogeneity issues have to be addressed. First, in all these specifications, the lagged dependent variable is endogenous since it is correlated with the state fixed effects in the composite error term ($\eta_i + \varepsilon_{it}$), which yields biased and inconsistent results if OLS or fixed effect estimators are applied (Nickell, 1981). Second, specification (12) shows that expenditure policies of the competitors enter contemporaneously, so that the competitors' expenditure decisions are endogenous and correlated with the error term (ε_{it}). OLS yields a biased estimate of parameter ρ (Anselin, 1988).[29] Beyond the endogeneity issues, another important concern is the estimation of the time-invariant variable $west_i$ in all the specifications. It is well known that dealing with the state fixed effects by the fixed effect estimator or first difference method will wipe out this time-invariant variable, which is one of the key variables in this study.

To circumvent all these problems, I employ the system GMM estimator developed by Blundell and Bond (1998), that has been used quite often in the recent studies on tax competition with dynamic features (Foucault et al., 2008; Ghinamo et al., 2010; Klemm and Van Parys, 2012). This estimator combines the moment conditions from both the first-differenced equation of the estimating equation and the estimating equation in levels, and then estimates the parameters by GMM.[30] In addition, following the standard spatial econometrics literature (Kelejian and Robinson, 1993; Kelejian and Prucha, 1998), I also use the competitors' weighted average of explanatory variables, including weighted real GDP per capita, weighted openness, weighted budget surplus, weighted public debt, and weighted population density, as extra exogenous instruments for the spatial lag variable (I_{-it}) in

[29] This second endogeneity is a typical issue in the spatial econometrics literature. Two conventional approaches for getting consistent estimates of the spatial parameter are suggested in the literature. The first approach is to use instrumental variables (Anselin, 1988). An alternative approach is to rely on the maximum likelihood (See Brueckner, 2003, for more discussion). Although both approaches yield consistent estimate of spatial parameter, the latter method is generally challenging in computation.

[30] In dealing with the endogenous variables, the system GMM estimator uses lagged levels to instrument the endogenous differences and lagged first differences to instrument levels.

specification (12).[31] Regarding the time-invariant variable $west_i$, although it sweeps out in the first-differenced equation, the levels equation still allows for identification of this variable since all instruments for the level equation are assumed to be orthogonal to state fixed effects (Roodman, 2009a).

The overall validity of the instruments used in the regressions as well as the serial correlation in the residuals are evaluated by the Hansen test (or overidentifying restriction test) and the Arellano and Bond (1991) test respectively. The former statistic tests the null hypothesis that the instruments are not correlated with the residuals, while the latter tests the presence of auto-correlation in the residuals.[32] Both statistics are necessary to confirm the validity of the instruments used. Finally, given my small sample size and a significant amount of additional instruments introduced, I restrict the lags to three and four years and collapse the instrument matrix when estimating specification (12) in order to avoid the problem of too many instruments as discussed in Roodman (2009a,b).

Ideally, one would also include time dummies in the specifications to prevent the most likely form of cross-state correlation, contemporaneous correlation. However, it generates two problems in my context. Due to the large amount of instruments created by the system GMM estimator together with the external instruments, adding time dummies may weaken the Hansen test and overfit the endogenous variable (Roodman, 2009a,b). Additionally, Devereux et al. (2008) and Klemm and Van Parys (2012) point out that the inclusion of time dummies in a model with spatial lag variables results in a possible multicollinearity issue among the spatial lag variables and the time dummies,[33] which makes it hard to identify the true impact of each variable. Therefore, following the suggestion by Devereux et al. (2008) and Klemm and Van Parys (2012), I add a linear time trend variable that captures common trend for all states, instead of using time dummies.

[31] The weights are constructed in the same way as the ones I discussed previously.

[32] Given the structure of the first-differences equation in the system GMM estimator, the first order correlation in the residuals is usually expected, but the second order correlation in the residuals should be avoided for a valid specification.

[33] The reason here is that the inclusion of time dummies is equivalent to adding the average value of the dependent variable in each year, which by its nature is highly correlated with the spatial lag variables.

4.3 Data

The panel dataset covers sixteen German states over the period 1995-2007. In this subsection, I explain the dataset in further detail, with a special focus on the measurements of the composition of public input expenditure and the MTRE.

To begin with, I_{it} is defined as the sum of state i's government expenditure on productive items in year t as percentage of the state's total budgetary expenditure. Since the functional classification of productive items turns out to be quite controversial in the literature, in this study, I follow the classification method defined by Thöne (2005), and recently employed by Hauptmeier (2009) in the German context. In Thöne's original study, he conducted an in-depth survey on the productivity effects of different government expenditure categories in the empirical literature, and then applied the resulting insights to the German system of budgetary accounting to generate a meaningful indicator for each of the expenditure categories. More specifically, the following two main expenditure categories are identified as productive expenditure based on his study: public infrastructure; and education, research and development (R&D). The first category includes expenditures on streets, waterways and ports, rail and public transport, aviation, and municipal services. The latter includes expenditures on schools and pre-school education, sponsorship of pupils, students, etc., universities, and research and development (outside universities). In general, expenditures on public infrastructure have the most direct economic impacts by reducing firms' production and transaction costs, while the economic impacts of expenditures on education and R&D are more long-term as it facilitates the build-up and maintenance of human capital in the economy (Kappeler and Välilä, 2008). Data on the detailed expenditure items are obtained from the German Federal Statistical Office. Figure 2 provides an overview of the evolution of public input expenditure in Germany over the time period covered. It shows averages for the measure of public input expenditure, classified by the whole country, East Germany and West Germany. The figure reveals a persistent tendency of higher expenditures on public input in West Germany than in East Germany, which tentatively sheds some light on C&T's

original hypothesis that initially well-endowed regions tend to spend more on public input than initially poorly-endowed regions.

The key variable of interest, MTRE, is simulated from a more complicated process since it is not directly observable. Note that the concept of MTRE is broadly defined as the fraction of one additional unit of own source revenue that flows out of the region in responding to the equalization mechanism. The fraction for each state in a particular year depends on the state's fiscal capacity in relative to its fiscal need, and the resulting equalization parameter it faces corresponds to the system arrangement specified in section 3. Given the German's equalization system is a three-stage procedure with varied definitions of fiscal capacity and equalized parameters in each stage, I resort to the simulation method to calculate the MTRE for each state in each year, based on a rich set of information. More specifically, I utilize a state's relevant tax revenue and population data defined in each of the three equalization stages to determine the particular equalization formula it should face, and then calculate the resulting changes of equalization payments for a hypothesized one unit increase in tax revenue. The overall MTRE for a state is obtained by adding the resulting changes of equalization payments in all the three stages, adjusted by the changing values of the hypothesized increase of own source tax revenue in different stages. A brief description of this simulation process can be found in the Appendix. Very detailed data on calculating a state's fiscal capacity and fiscal need in all three stages are obtained from the annual enactments (1995-2007) to implement the fiscal equalization law.

Data for all other variables are derived from the German Federal Statistical Office, with the exception of information on election year and partisan affiliation, which in turn are collected from the website *http://www.election.de/*. Summary statistics of all the variables are given in Table 2.

5 Results

5.1 Main results

All specifications are estimated by the system GMM method explained above, along with robust and finite sample corrected standard errors. The Hansen test and the Arellano and Bond (1991) test are reported at the bottom of each table, indicating the validity of the instruments used. Given the fact that the German equalization system changed slightly in 2005, I present the estimation results for the time period 1995-2004 as main results for the analysis, and later report the results from a longer period as robustness checks.

Column (1) in Table 3 reports the estimation results of the baseline specification (10) assuming no regional interactions. I find a positive and significant coefficient of the measurement of heterogeneous regions ($west_i$) in line with C&T's original hypothesis that initially well-endowed regions (i.e., West German states) tend to spend higher proportion on public input expenditure than their poorly-endowed counterparts (i.e., East German states). A negative and significant estimate of the MTRE implies that higher marginal tax rate on any potential increments of tax revenues produced by investments on public input cuts a state's expenditures on public input, supporting *Testable Implication* 1 (i). Turning to the effects of regional interactions, I present the estimation results of specification (12) in columns (2), (3), and (4) of Table 3 with alternative definitions of weighting matrices described in the previous section. Similarly, results are strongly in line with the theoretical predictions described in *Testable Implication* 1(ii)–the competing states' MTRE positively and significantly affects the home state's public input expenditure.

Considering the magnitudes of the effects, West German states spend roughly 3 to 4 percentage points more on public input expenditure than East German states. A one percentage point increase in the MTRE will reduce the proportion of public input expenditure by about 0.09 percentage points in the estimation without considering regional interactions, and by about 0.05 percentage points when controlling regional interactions. As summarized

in Table 1, most states have a value of MTRE around or above 80%. This implies that, other things being equal, if the MTRE is reduced to zero, state public input expenditure will be increased on average by about 14%.[34] The effect from the competing states' MTRE turns out to be relatively much stronger, it has an estimated coefficient amounts to roughly five times as large as the home state's MTRE, suggesting that spatial interactions play an important role in the determination of the home state's expenditure policy. Nevertheless, this relatively large magnitude of the effect from the competing states needs to be interpreted with caution, since it clearly, as I will show in more details later, depends on the methods I adopt to define the weighing schemes.

As far as the control variables are concerned, the lagged dependent variable has a positive and significant coefficient, indicating high persistence of the expenditure policies. A positive and significant effect from the competitors' weighted public input expenditure provides evidence on the existence of strategic interaction among states' public input expenditure which in turn is the fundamental assumption of this study. Real GDP per capita is negative and significant in all four models, suggesting that a state with higher income level in the past period may care more about people's well-being, and so spend more on welfare expenditures.[35] Openness has positive but not significant effect. While the short-term fiscal position, measured by the budget surplus, has negative but mostly insignificant effect, higher public debt capturing the effect of long-term fiscal position significantly reduces investments on public input. As expected, densely populated states tend to spend higher proportion of expenditures on productive items, though the estimates are only statistically significant at the margin. This indicates a higher demand of public input networks in these states. Moreover, the results also show that states have a tendency to spend more on productive expenditure

[34] I assume the estimated coefficient of MTRE taking a value of 0.05; and note that the mean value of public input expenditure as a percentage of total expenditure for all states amounts to 29.4% (see Table 2).

[35] One may argue that real GDP per capita is highly correlated with the measurement of heterogeneous region. But I believe that the former mostly captures the wealth level of the state in current period, while the latter captures a greater difference in many aspects of the two types of regions at the beginning period. As a matter of fact, dropping real GDP per capita from the regressions does not affect my main results. These results are not reported in the paper, but they are available upon requested.

during election periods,[36] though partisan affiliation does not reflect significantly different preferences over the composition of public expenditure.

5.2 Sensitivity analysis

In order to test for the robustness of the main results, I conduct sensitivity analysis along two dimensions. First, I re-estimate the specifications based on a longer time period covering 1995 to 2007, which includes additional observations from the new settings of the equalization system. It is expected that the results should be largely consistent with the main results, as the basic structure and mechanism of the system have not been changed. Second, I utilize alternative definitions of the weighting matrices to estimate specification (12). The rationale here is that the results I obtained so far have been derived under specific assumptions with respect to the weighting matrices. More specifically, the above three weighting schemes are constructed in a way that fits the theoretical assumption regarding the competition among two types of regions. This specific construction certainly has its own benefits in exactly identifying the theoretical question but, in a broader sense and as in related studies, the implications of the model may also be applied to any types of the competing states. It therefore seems to be warranted to relax this assumption in constructing the weighing schemes. To do so, I follow the existing literature to reconstruct the above three weighting schemes (i.e., weight I, weight II, and weight III) by disregarding their types of initial endowments. That is, instead of defining the competing states of state i as its opposite type of states, I simply use all the states except state i itself. I denote these three additional weighting schemes as weight IV, weight V, and weight VI, respectively. In addition, I also follow most of the spatial econometrics literature to construct two more weighting matrices, which accounts for both the geographic closeness between states and the differences in the states' size. More specifically, the typical elements for these two weights (denoted as "weight VII" and "weight VIII") are, $w_{ij} = \frac{c_{ij}pop_{jt}}{\sum_{j\neq i} c_{ij}pop_{jt}}$ and $w_{ij} = \frac{d_{ij}pop_{jt}}{\sum_{j\neq i} d_{ij}pop_{jt}}$, where c_{ij} is a border dummy which

[36] These estimates are in general statistically significant in a one-tail test at the 10% level.

equals one when state i and j share a common border and zero otherwise (with $c_{ii} = 0$); d_{ij} is the inverse distance between state i and j (with $d_{ii} = 0$); and pop_{jt} denotes population size of state j in year t.

Tables 4 reports results obtained from estimations with data from 1995 to 2007. As expected, the inclusion of more information gives qualitatively similar results to those obtained before; and with more observations, the estimates for some control variables including budget surplus, population density, and election become statistically more significant. However, as noted earlier, the magnitudes of the estimated coefficients for competing states' MTRE are reduced by roughly a half in two out of the three cases (see columns (2) and (3) in Table 4), even though the magnitudes for the measurement of heterogeneous regions and the home state's MTRE remain relatively comparable. Table 5 documents the results obtained with alternative weighting schemes. In all cases, the results are consistent with the main ones, which provide further robust evidence on the role of initial endowments and the equalization system in affecting the state's expenditure policy. Similarly, these results also repeat the caution message that the magnitude effect of the equalization system, especially for the competing states' MTRE, has to be interpreted carefully, as it varies across different definitions of the weighting matrices.[37]

6 Conclusion

The paper explores the potential role of an equalization transfer system in correcting the distortion of competition for capital among heterogeneous regions in initial endowments. This distortion has been particularly claimed by C&T, arguing that competition among these heterogeneous regions leads to a "one-sided" disciplining effect on regional governments' expenditure policies: only well-endowed regions end up with more productive expenditure policies, while poorly-endowed counterparts do the opposite. I add a conventional equal-

[37] As shown in Table 5, the estimated coefficient of MTRE ranges from -0.127 to -0.064, while the corresponding value for the competing states' MTRE ranges from 0.07 to 0.285.

ization system to C&T's original model and show how this "one-sided" disciplining effect can be corrected by the system with desired parameter settings. In particular, it requires the central government to set a relatively higher equalization degree for the well-endowed regions, which at the end converts to generate a larger disincentive effect for the governments in these regions to expand their tax base by choosing higher level of public input expenditure.

The basic predictions of the model are tested by the German equalization system, which closely matches the model assumptions and identification needs. Apart from the finding confirming the emergence of "one-sided" disciplining effect among West and East German states, my estimations validate the prediction that the equalization system exerts a significant role in affecting the states' expenditure behaviors–a result that can be utilized by the central government for its design of an effective equalization system to tackle the regional divergent expenditure policies driven by the regional heterogeneity of initial endowments.

These findings have significant policy relevance. As decentralization has been widely implemented in many countries around the world, where heterogeneity in natural resources, human capital, or infrastructure are largely observed across different regions, there will be a need for rethinking some corrective policies from the central government that can remedy the "one-sided" disciplining effect in order to avoid an even worse outcome of regional disparity. In this particular context, there are many reasons why an equalization system might be favored. Beyond the most usual argument in supporting this system to reduce regional disparities in fiscal capacity and the additional reasoning in favoring its role in internalizing the externality of tax competition as found in some recent literature, I supplement this support by highlighting its role in balancing regional expenditure policies and so contributing to long-run balanced regional development. In all, I present a different point of view to that of C&T in the sense that, I believe decentralization may also be able to achieve the goal of imposing discipline on local governments in heterogeneous countries, where a well-designed fiscal equalization system shall play an essential role for the success of the countries' decentralization policy.

References

Anselin, L. (1988). *Spatial econometrics: methods and models*. Studies in operational regional science, Kluwer Academic Publishers.

Arellano, M., and Bond, S. (1991). "Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations." *The Review of Economic Studies*, *58*(2), pp. 277–297.

Baretti, C., Huber, B., and Lichtblau, K. (2002). "A tax on tax revenue: The incentive effects of equalizing transfers: Evidence from Germany." *International Tax and Public Finance*, *9*(6), 631–649.

Barrell, R., and Te Velde, D. W. (2000). "Catching-up of East German labour productivity in the 1990s." *German Economic Review*, *1*(3), 271–297.

Bayern Staatsministerium der Finanzen (2005). *Der bundesstaatliche Finanzausgleich: Überblick, Zielsetzung, Instrumente*. Bayerisches Staatsministerium der Finanzen, Abt. Finanzpolitik.

Blundell, R., and Bond, S. (1998). "Initial conditions and moment restrictions in dynamic panel data models." *Journal of Econometrics*, *87*(1), 115 – 143.

Boadway, R., and Flatters, F. (1982). "Efficiency and equalization payments in a federal system of government: A synthesis and extension of recent results." *The Canadian Journal of Economics*, *15*(4), pp. 613–633.

Brand, D. (2006). *Financial Constitutional Law: A Comparison Between Germany and South Africa*. Konrad Adenauer Stiftung.

Breuillé, M.-L., Madiès, T., and Taugourdeau, E. (2010). "Gross versus net equalization scheme in a federation with decentralized leadership." *Journal of Urban Economics*, *68*(2), 205 – 214.

Brueckner, J. K. (2003). "Strategic interaction among governments: An overview of empirical studies." *International Regional Science Review*, *26*(2), 175–188.

Büttner, T. (2006). "The incentive effect of fiscal equalization transfers on tax policy." *Journal of Public Economics*, *90*(3), 477–497.

Büttner, T., Hauptmeier, S., and Robert, S. (2011). "Efficient revenue sharing and upper level governments: Theory and application to Germany." *Journal of Theoretical and Institutional Economics*, *167*(4), 647–667.

Bucovetsky, S., and Smart, M. (2006). "The efficiency consequences of local revenue equalization: Tax competition and tax distortions." *Journal of Public Economic Theory*, *8*(1), 119–144.

Burda, M. C., and Hunt, J. (2001). "From reunification to economic integration: Productivity and the labor market in Eastern Germany." *Brookings Papers on Economic Activity*, *32*(2), 1–92.

Cai, H., and Treisman, D. (2005). "Does competition for capital discipline governments? decentralization, globalization, and public policy." *The American Economic Review*, *95*(3), pp. 817–830.

Cumberland, J. H. (1981). "Efficiency and equity in interregional environmental management." *Review of Regional Studies*, *10*(2), 1–9.

Czarnitzki, D. (2005). "The extent and evolution of productivity deficiency in Eastern Germany." *Journal of Productivity Analysis*, *24*, 211–231.

Dembour, C. (2008). "Competition for business location: A survey." *Journal of Industry, Competition and Trade*, *8*, 89–111.

Devereux, M. P., Lockwood, B., and Redoano, M. (2008). "Do countries compete over corporate tax rates?" *Journal of Public Economics*, *92*(5-6), 1210–1235.

Egger, H., and Falkinger, J. (2006). "The role of public infrastructure and subsidies for firm location and international outsourcing." *European Economic Review*, *50*(8), 1993–2015.

Egger, P., Koethenbuerger, M., and Smart, M. (2010). "Do fiscal transfers alleviate business tax competition? evidence from Germany." *Journal of Public Economics*, *94*(3-4), 235–246.

Foucault, M., Madies, T., and Paty, S. (2008). "Public spending interactions and local politics. empirical evidence from French municipalities." *Public Choice*, *137*(1), 57–80.

Ghinamo, M., Panteghini, P., and Revelli, F. (2010). "FDI determination and corporate tax competition in a volatile world." *International Tax and Public Finance*, *17*(5), 532–555.

Hauptmeier, S. (2009). "Fiscal competition and the impact of fiscal equalisation." Munich Dissertations in Economics 9691, University of Munich, Department of Economics.

Hepp, R., and von Hagen, J. (2012). "Fiscal federalism in Germany: Stabilization and redistribution before and after unification." *Publius: The Journal of Federalism*, *42*(2), 234–259.

Hindriks, J., Peralta, S., and Weber, S. (2008). "Competing in taxes and investment under fiscal equalization." *Journal of Public Economics*, *92*(12), 2392 – 2402.

Ivanyna, M. (2010). *Quality of governance and its impact on interjurisdictional competition*. Ph.D. thesis, Universität Regensburg.

Jacobs, J., Ligthart, J., and Vrijburg, H. (2010). "Consumption tax competition among governments: Evidence from the United States." *International Tax and Public Finance*, *17*, 271–294.

Kappeler, A., and Välilä, T. (2008). "Fiscal federalism and the composition of public investment in Europe." *European Journal of Political Economy*, *24*(3), 562 – 570.

Keen, M., and Marchand, M. (1997). "Fiscal competition and the pattern of public spending." *Journal of Public Economics*, *66*(1), 33–53.

Keen, M. J., and Kotsogiannis, C. (2004). "Tax competition in federations and the welfare consequences of decentralization." *Journal of Urban Economics*, *56*(3), 397–407.

Kelejian, H. H., and Prucha, I. R. (1998). "A generalized spatial two-stage least squares procedure for estimating a spatial autoregressive model with autoregressive disturbances." *The Journal of Real Estate Finance and Economics*, *17*, 99–121.

Kelejian, H. H., and Robinson, D. P. (1993). "A suggested method of estimation for spatial interdependent models with autocorrelated errors, and an application to a county expenditure model." *Papers in Regional Science*, *72*, 297–312.

Klemm, A., and Van Parys, S. (2012). "Empirical evidence on the effects of tax incentives." *International Tax and Public Finance*, *19*, 393–423.

Köthenbürger, M. (2002). "Tax competition and fiscal equalization." *International Tax and Public Finance*, *9*, 391–408.

Köthenbürger, M. (2004). "Tax competition in a fiscal union with decentralized leadership." *Journal of Urban Economics*, *55*(3), 498 – 513.

Köthenbürger, M. (2005). "Leviathans, federal transfers, and the cartelization hypothesis." *Public Choice*, *122*, 449–465.

Losco, V. (2006). "Competition and Equalization: Rethinking German Federalism after Recent Legislative Reform." *SSRN eLibrary*.

Mehrotra, A., and Välilä, T. (2006). "Public investment in Europe: Evolution and determinants in perspective." *Fiscal Studies*, *27*(4), 443–471.

Nickell, S. (1981). "Biases in dynamic models with fixed effects." *Econometrica*, *49*(6), pp. 1417–1426.

Qian, Y., and Roland, G. (1998). "Federalism and the soft budget constraint." *The American Economic Review*, *88*(5), pp. 1143–1162.

Rom, M. C., Peterson, P. E., and Scheve, K. F. (1998). "Interstate competition and welfare policy." *Publius: The Journal of Federalism*, *28*(3), 17–37.

Roodman, D. (2009a). "How to do xtabond2: An introduction to difference and system GMM in Stata." *Stata Journal*, *9*(1), 86–136.

Roodman, D. (2009b). "A note on the theme of too many instruments." *Oxford Bulletin of Economics and Statistics*, *71*(1), 135–158.

Schulze, G. G., and Ursprung, H. W. (1999). "Globalisation of the economy and the nation state." *The World Economy*, *22*(3), 295–352.

Smart, M. (1998). "Taxation and deadweight loss in a system of intergovernmental transfers." *The Canadian Journal of Economics*, *31*(1), pp. 189–206.

Smart, M. (2007). "Raising taxes through equalization." *Canadian Journal of Economics*, *40*(4), 1188–1212.

Sørensen, P. B. (2004). "International tax coordination: regionalism versus globalism." *Journal of Public Economics*, *88*(6), 1187–1214.

Thöne, M. (2005). "Wachstums- und nachhaltigkeitswirksame öffentliche ausgaben (wna)." *FiFo-Berichte Nr. 2, Koeln*.

Werner, J. (2008). "Fiscal equalisation among the states in Germany." Working Papers 02-2008, Institute of Local Public Finance.

Wilson, J. D. (1999). "Theories of tax competition." *National Tax Journal*, *52*, 269–304.

Wilson, J. D., and Wildasin, D. E. (2004). "Capital tax competition: bane or boon." *Journal of Public Economics*, *88*(6), 1065–1091.

Zhang, X. (2006). "Fiscal decentralization and political centralization in China: Implications for growth and inequality." *Journal of Comparative Economics*, *34*(4), 713–726.

Appendix A: Equilibrium Solution of the Model

The problem of region i is to choose the level of I_i independently so as to maximize its objective function (3), subject to its budget constraint (5). The first order condition (FOC) gives

$$(1-t+\lambda t+\lambda \upsilon_i t\frac{p_i}{\sum_i p_i}-\lambda \upsilon_i t)(\frac{\partial F_i}{\partial K_i}\frac{\partial K_i}{\partial I_i}+\frac{\partial F_i}{\partial I_i})+\lambda \upsilon_i t\frac{p_i}{\sum_i p_i}\sum_{j\neq i}\frac{\partial F_j}{\partial K_j}\frac{\partial K_j}{\partial I_i}=\lambda \qquad (14)$$

Given market clearing condition (2) and total stock of capital in the economy is fixed $\sum_i K_i=\bar{K}$, it is straightforward to find that $\frac{\partial F_i}{\partial K_i}=\frac{r}{1-t}$, for all i and $\frac{\partial K_i}{\partial I_i}=-\sum_{j\neq i}\frac{\partial K_j}{\partial I_i}$. Substituting these two conditions, along with the capital allocation rule $K_i=(\frac{1}{r}(1-t)\alpha A_i I_i^{\beta})^{\frac{1}{1-\alpha}}$ and the aggregate production function (1) into equation (14), I derive the decision rule for investments in public input as

$$I_i=(\frac{1}{\lambda}\beta A_i K_i^{\alpha}\tau_i)^{\frac{1}{1-\beta}} \qquad (15)$$

Thereby, the capital allocation rule $K_i=(\frac{1}{r}(1-t)\alpha A_i I_i^{\beta})^{\frac{1}{1-\alpha}}$ and the public input decision rule (15) jointly characterize the equilibrium of the model. The solution to these two equations system is presented in equations (6) and (7).

Appendix B: Simulation of the MTRE in Germany

In this appendix, I provide a brief description of the simulation method I employed to calculate the MTRE for each state covering the period 1995-2007. My method is similar to those of Baretti et al. (2002), Hauptmeier (2009), and Büttner et al. (2011), but with a novel distinction that I include the case of the new system arrangements which took effective from 2005 onward.[38]

The essence of the calculation is to identify the fraction of a one unit additional tax revenue in a state that flows out of the state due to the functioning of the equalization system. Given the German's equalization system is a three-stage procedure with varied equalization rules and definitions of fiscal capacity in each stage, this simulation of the MTRE can only be achieved by calculating the marginal change of the state's transfers from (or its contributions to) the equalization system stage by stage, and then adding up all the resulting information. More specifically, let us denote t_i^s and n_i^s as state i's fiscal capacity and fiscal need in stage s ($s=1,2,3$) of the LFA system respectively.[39] Following the federal

[38] A more detailed discussion on the simulation is available upon request from the author.

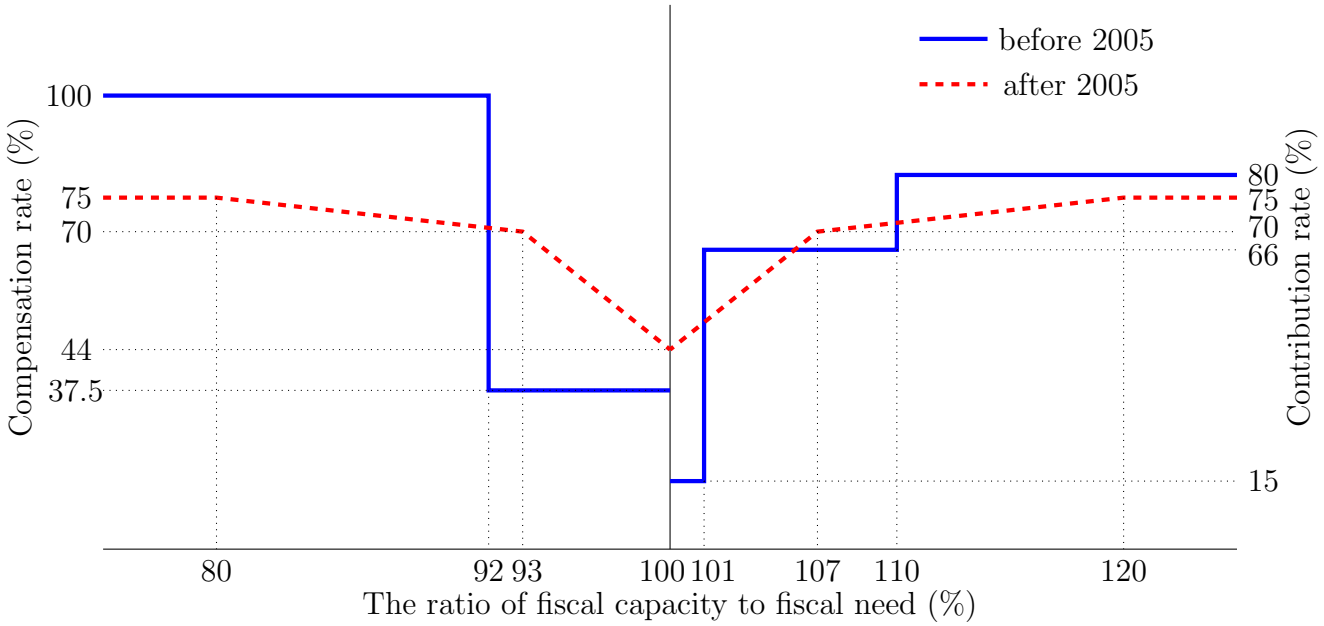
[39] All notations represent values in one particular year. Note that tax revenues that are considered as

fiscal equalization rules specified in section 3 and depending on the value of $\frac{t_i^s}{n_i^s}$, I determine the particular equalization formula that the state should face to calculate its transfers from (or its contributions to) the equalization system, i.e. $G_i^s = f(\frac{t_i^s}{n_i^s})$. The marginal effect of an increase of fiscal capacity in state i for stage s is then given by the first derivative of G_i^s with respect to t_i^s, i.e. $\frac{\partial G_i^s}{\partial t_i^s}$.

Finally, in order to calculate the overall MTRE of a state in a particular year, I consider the experiment that personal income tax revenue increases by one unit. Due to the tax sharing mechanism I described in section 3, 42.5% of personal income tax revenue accrues to the federal government, while the rests are allocated between state and municipality governments at a rate of 42.5% and 15% respectively. Thus the MTRE is at least 0.425 for the portion goes to the federal government. Then the LFA system comes into effect for the rest 0.575 unit increment of income tax: since during stage 1 only pure state taxes and a state's share of corporate income tax and personal income tax are taken into account as fiscal capacity, so stage 1 increases the MTRE by $0.425|\frac{\partial G_i^1}{\partial t_i^1}|$; during stage 2, 50% of the tax revenues of its municipalities is also included in the calculation of fiscal capacity, so stage 2 increases the MTRE by $(0.425 * (1 - |\frac{\partial G_i^1}{\partial t_i^1}|) + 0.15 * 0.5) * |\frac{\partial G_i^2}{\partial t_i^2}|$; lastly, stage 3 increases the MTRE by $(0.425 * (1 - |\frac{\partial G_i^1}{\partial t_i^1}|) + 0.15 * 0.5) * (1 - |\frac{\partial G_i^2}{\partial t_i^2}|) * |\frac{\partial G_i^3}{\partial t_i^3}|$. In sum, the overall MTRE for each state can be presented as follows

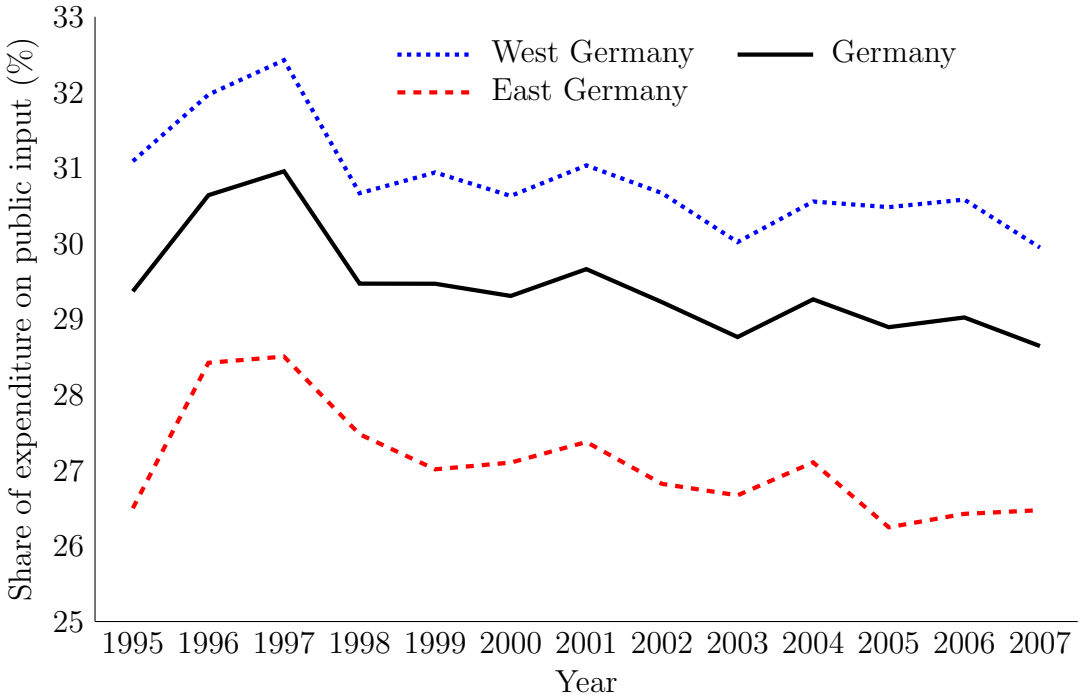
$$\begin{aligned} MTRE = 0.425 + 0.425|\frac{\partial G_i^1}{\partial t_i^1}| + (0.425 * (1 - |\frac{\partial G_i^1}{\partial t_i^1}|) + 0.15 * 0.5) * |\frac{\partial G_i^2}{\partial t_i^2}| \\ +(0.425 * (1 - |\frac{\partial G_i^1}{\partial t_i^1}|) + 0.15 * 0.5) * (1 - |\frac{\partial G_i^2}{\partial t_i^2}|) * |\frac{\partial G_i^3}{\partial t_i^3}|. \end{aligned}$$

states' fiscal capacity vary across different stages of the LFA system. The state's corresponding fiscal need in stage s, n_i^s, is simply the per capita average of all the states' fiscal capacity in that stage multiplied by the state's population.



Source: Bayern Staatsministerium der Finanzen (2005)

Figure 1. Marginal rates of compensation/contribution before and after 2005 in the second stage of the LFA



Source: Author's calculation

Figure 2. Average of expenditure on public input over the years

Table 1: Average Value of Marginal Tax Rate of Equalization in Germany

States	**Overall** (1995-2007)	**Solidarity Part I** (1995-2004)	**Solidarity Part II** (2005-2007)
East Germany			
Berlin	0.908	0.912	0.893
Brandenburg	0.923	0.925	0.917
Mecklenburg-Vorpommern	0.923	0.925	0.918
Sachsen	0.922	0.924	0.916
Sachsen-Anhalt	0.923	0.925	0.917
Thüringen	0.923	0.925	0.917
West Germany			
Baden-Württemberg	0.756	0.759	0.745
Bayern	0.752	0.757	0.737
Bremen	0.893	0.921	0.797
Hamburg	0.776	0.776	0.777
Hessen	0.791	0.797	0.773
Niedersachsen	0.896	0.894	0.905
Nordrhein-Westfalen	0.753	0.736	0.810
Rheinland-Pfalz	0.894	0.888	0.913
Saarland	0.923	0.925	0.918
Schleswig-Holstein	0.890	0.883	0.913

Source: Author's calculations.

Note: The simulation is conducted by assuming a one unit increase in income tax revenue.

Table 2: Summary statistics

Variable	**Mean**	**Std. Dev.**	**Min.**	**Max.**	**Obs.**
Share of public input expenditure (I_{it})	0.294	0.041	0.212	0.386	208
West	0.625	0.485	0	1	208
MTRE	0.865	0.074	0.690	0.925	208
GDP per capita, log	10.132	0.272	9.686	10.758	208
Openness	0.437	0.233	0.079	1.032	208
Budget surplus (% of GDP)	-0.013	0.015	-0.072	0.056	208
Public debt (% of GDP)	0.299	0.121	0.087	0.724	208
Population density, log	5.745	1.112	4.283	8.268	208
Election	0.212	0.409	0	1	208
Party affiliation	0.505	0.501	0	1	208

Source: Author's calculations.

Table 3: Estimation results for the effects of initial endowment and the equalization system

Dependent variable: I_{it}	(1)	(2)	(3)	(4)
		Weight I	Weight II	Weight III
I_{it-1}	0.334***	0.530***	0.568***	0.563***
	(2.98)	(4.92)	(5.89)	(5.48)
I_{-it}		0.969***	0.858***	1.109***
		(4.14)	(4.03)	(4.46)
West	0.037***	0.038**	0.026*	0.030*
	(3.98)	(2.54)	(1.87)	(1.81)
$MTRE_{it-1}$	-0.087**	-0.055*	-0.049*	-0.048*
	(-2.52)	(-1.95)	(-1.76)	(-1.81)
$MTRE_{-it-1}$		0.245***	0.271***	0.286***
		(3.47)	(3.55)	(2.64)
GDP per capita $t-1$	-0.091***	-0.069***	-0.065***	-0.066***
	(-4.00)	(-4.17)	(-4.16)	(-4.22)
Openness $t-1$	0.016	0.014	0.017	0.017
	(0.71)	(0.77)	(1.04)	(1.01)
Budget surplus $t-1$	-0.236**	-0.113	-0.143	-0.162
	(-2.22)	(-1.00)	(-1.30)	(-1.55)
Public debt $t-1$	-0.169***	-0.126***	-0.122***	-0.125***
	(-5.12)	(-4.43)	(-4.63)	(-4.69)
Population density $t-1$	0.003	0.003	0.003	0.003
	(1.16)	(1.33)	(1.31)	(1.38)
Election $t-1$	0.001	0.002	0.002	0.003
	(0.82)	(1.52)	(1.39)	(1.45)
Party affiliation $t-1$	-0.004	-0.004	-0.003	-0.003
	(-0.76)	(-0.87)	(-0.85)	(-0.83)
Constant	1.189***	0.363*	0.330*	0.254
	(4.92)	(1.7)	(1.71)	(1.17)
State fixed effect	Yes	Yes	Yes	Yes
Time trend	Yes	Yes	Yes	Yes
Observations	144	144	144	144
Number of states	16	16	16	16
Hansen test (p-value)	0.346	0.98	0.883	0.924
AR(1) (p-value)	0.008	0.002	0.003	0.002
AR(2) (p-value)	0.688	0.788	0.871	0.742

Notes: Robust t-statistics in parentheses. Time period is 1995-2004. Models are estimated by system GMM estimator. I_{-it} and $MTRE_{-it-1}$ are the weighted averages of values of the competing states (the opposite type of states)' public input expenditures and marginal tax rate of equalization respectively. I_{-it} is instrumented by weighted real GDP per capita, weighted openness, weighted budget surplus, weighted public debt, and weighted population density. The lagged dependent variable is instrumented by higher-order lags (restricted to $t-3$ to $t-4$) of the dependent variable. The remaining explanatory variables are considered to be exogenous and therefore also included in the instrument matrix. ***, **, * denote significance at the 1, 5, and 10% level, respectively.

Table 4: Sensitivity checks: estimation results with alternative time period

Dependent variable: I_{it}	(1)	(2)	(3)	(4)
		Weight I	Weight II	Weight III
I_{it-1}	0.388***	0.546***	0.611***	0.538***
	(2.90)	(4.56)	(4.34)	(4.17)
I_{-it}		1.076***	0.951***	1.224***
		(4.37)	(3.98)	(4.99)
West	0.034***	0.051***	0.041***	0.037**
	(3.52)	(3.12)	(2.60)	(2.16)
$MTRE_{it-1}$	-0.093***	-0.059**	-0.048*	-0.064***
	(-3.56)	(-2.24)	(-1.87)	(-2.66)
$MTRE_{-it-1}$		0.145**	0.126**	0.295**
		(2.13)	(2.10)	(2.21)
GDP per capita $t-1$	-0.096***	-0.077***	-0.068***	-0.081***
	(-4.23)	(-5.27)	(-4.17)	(-4.66)
Openness $t-1$	0.005	0.008	0.01	0.009
	(0.27)	(0.45)	(0.65)	(0.52)
Budget surplus $t-1$	-0.149*	-0.073	-0.092	-0.152*
	(-1.82)	(-0.74)	(-0.96)	(-1.73)
Public debt $t-1$	-0.162***	-0.136***	-0.123***	-0.138***
	(-3.86)	(-4.82)	(-3.70)	(-4.14)
Population density $t-1$	0.007**	0.006***	0.005***	0.006***
	(2.42)	(3.14)	(2.72)	(3.19)
Election $t-1$	0.002**	0.003**	0.003**	0.003**
	(2.08)	(2.44)	(2.19)	(2.13)
Party affiliation $t-1$	-0.002	-0.0003	0.0005	-0.001
	(-0.44)	(-0.08)	-0.17	(-0.22)
Constant	1.212***	0.483***	0.423**	0.363*
	(4.75)	(2.67)	(2.43)	(1.84)
State fixed effect	Yes	Yes	Yes	Yes
Time trend	Yes	Yes	Yes	Yes
Observations	192	192	192	192
Number of states	16	16	16	16
Hansen test (p-value)	0.935	1.000	0.999	0.985
AR(1) (p-value)	0.005	0.002	0.002	0.002
AR(2) (p-value)	0.636	0.289	0.457	0.212

Notes: Robust t-statistics in parentheses. Time period is 1995-2007. Models are estimated by system GMM estimator. I_{-it} and $MTRE_{-it-1}$ are the weighted averages of values of the competing states (the opposite type of states)' public input expenditures and marginal tax rate of equalization respectively. I_{-it} is instrumented by weighted real GDP per capita, weighted openness, weighted budget surplus, weighted public debt, and weighted population density. The lagged dependent variable is instrumented by higher-order lags (restricted to $t-3$ to $t-4$) of the dependent variable. The remaining explanatory variables are considered to be exogenous and therefore also included in the instrument matrix. ***, **, * denote significance at the 1, 5, and 10% level, respectively.

Table 5: Sensitivity checks: estimation results with alternative weighting schemes

Dependent variable: I_{it}	(1)	(2)	(3)	(4)	(5)
	Weight IV	Weight V	Weight VI	Weight VII	Weight VIII
I_{it-1}	0.478***	0.369*	0.451***	0.429***	0.669***
	(2.74)	(1.88)	(2.59)	(2.63)	(6.99)
I_{-it}	0.875***	0.834***	0.757**	0.576***	0.320***
	(3.93)	(3.83)	(2.39)	(2.90)	(3.61)
West	0.031**	0.040***	0.036***	0.034***	0.015***
	(2.32)	(2.63)	(2.64)	(3.06)	(2.61)
$MTRE_{it-1}$	-0.064†	-0.091*	-0.074*	-0.083**	-0.127**
	(-1.51)	(-1.80)	(-1.77)	(-1.98)	(-2.18)
$MTRE_{-it-1}$	0.285***	0.183*	0.236*	0.070†	0.156**
	(2.61)	(1.90)	(1.83)	(1.51)	(2.03)
GDP per capita $t-1$	-0.082***	-0.094***	-0.087***	-0.085***	-0.065***
	(-3.24)	(-3.30)	(-3.34)	(-3.65)	(-3.24)
Openness $t-1$	0.017	0.014	0.012	-0.008	0.024
	(0.86)	(0.60)	(0.51)	(-0.28)	(1.44)
Budget surplus $t-1$	-0.151	-0.180	-0.216*	-0.299***	-0.209***
	(-1.13)	(-1.22)	(-1.90)	(-3.34)	(-2.66)
Public debt $t-1$	-0.142***	-0.150***	-0.144***	-0.111***	-0.058**
	(-4.19)	(-3.59)	(-3.10)	(-2.84)	(-2.46)
Population density $t-1$	0.003	0.003	0.003	0.008*	0.001
	(1.01)	(0.83)	(1.04)	(1.81)	(0.29)
Election $t-1$	0.002	0.001	0.001	0.001	0.001
	(1.08)	(0.96)	(0.54)	(0.59)	(0.53)
Party affiliation $t-1$	-0.004	-0.009	-0.006	-0.004	-0.003
	(-0.51)	(-0.89)	(-0.76)	(-0.49)	(-0.89)
Constant	0.523	0.803**	0.674*	0.817***	0.623**
	(1.42)	(2.13)	(1.82)	(3.30)	(2.40)
State fixed effect	Yes	Yes	Yes	Yes	Yes
Time trend	Yes	Yes	Yes	Yes	Yes
Observations	144	144	144	144	144
Number of states	16	16	16	16	16
Hansen test (p-value)	0.99	0.986	0.882	0.325	0.322
AR(1) (p-value)	0.022	0.035	0.022	0.031	0.005
AR(2) (p-value)	0.777	0.643	0.717	0.964	0.946

Notes: Robust t-statistics in parentheses. Time period is 1995-2004. Models are estimated by system GMM estimator. I_{-it} and $MTRE_{-it-1}$ are the weighted averages of values of the competing states (all other states)' public input expenditures and marginal tax rate of equalization respectively. I_{-it} is instrumented by weighted real GDP per capita, weighted openness, weighted budget surplus, weighted public debt, and weighted population density. The lagged dependent variable is instrumented by higher-order lags (restricted to $t-3$ to $t-4$) of the dependent variable. The remaining explanatory variables are considered to be exogenous and therefore also included in the instrument matrix. ***, **, * denote significance at the 1, 5, and 10% level, respectively. † represent significance at the 10% level under one-tail test.