Interregional Redistribution and Regional Disparities: How Equalization Does (Not) Work [1]

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Abstract

Do inter-governmental transfers such as equalization grants reduce interregional disparities? This paper studies both theoretically and empirically the impact of interregional redistribution on interregional inequality. We set up a model with residential choice and equalization grants between regions, and show that interregional transfer payments prevent convergence promoting migration. We test our model in using cross-country data and panel data for 23 highly developed OECD countries. The evidence suggests a positive relationship between interregional transfers and regional disparities both across countries and over time from 1982 to 2000. In the cross-section data, we find that countries with higher levels of interregional redistribution in the past show a subsequent increase in interregional disparity, while countries with lower levels of grants and transfers show less divergence or even convergence. The panel reveals a similar picture: countries who have increased their sub-governmental transfers and grants have experienced more divergence (less convergence) over time than countries who have lowered their transfers.

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1 Introduction

The majority of high-income countries are organized as federations, where sub-national jurisdictions are unified to a larger entity with a common market, each jurisdiction endowed with a certain level of autonomy. The main arguments for this organizational form are based on efficiency enhancing economic integration and Oates' *Decentralization Theorem* recommending a decentralized provision of local public goods [Oates (1972)]. In the last decades, this institutional arrangement has become so popular that several countries decided to incorporate in supra-national institutions with the European Union as the most prominent example. However, a federal government structure might have disadvantages, e.g. if externalities between jurisdictions are not incorporated [Wilson (1999), Wilson and Wildasin (2004)]. Horizontal or vertical grants are a feasible instrument to internalize these externalities. In addition, governments use grants in order to diminish regional inequalities. The aim of these payments is to help poorer regions to catch up with the richer ones. Such redistributive transfer schemes can be found in most federations as e.g. Canada, Italy, Germany, or the EU. While these federations use unconditional grants in explicit equalization programs, other countries redistribute in a more indirect way as e.g. the U.S., where several formula grants consider a state's personal income in determining federal support.

The extent of equalization grants is considerable. In Germany, for example, as a country with a cooperative federal style, more than 7 billion Euro were redistributed between German states (*Länderfinanzausgleich*) in 2007 accompanied by 10 billion Euro vertical transfers to the East German states (*Sonderbedarfsbundesergänzungszuweisungen*).[2] Altogether, the share of transfers in total government revenues is 6.3%. The purpose of these transfers is explicitly the equalization of living standards across the nation.[3] Redistributive grants exist also in countries with a competitive federal structure as e.g. Switzerland. In 2008 the estimated amout of horizontal grants will amount to CHF 1.26 billion, while vertical grants will amount to CHF 1.80 billion.[4] Considering total government revenues for Switzerland in the amount of CHF 58 billion, the share of transfers in total revenues is 5.3%. These payments are supposed to explicitly strenghten the financial power of disadvantaged and poor

[2] Source: German Federal Ministry of Transport, Building and Urban Affairs, http://www.bmvbs.de/-,1663/knoten.htm.
[3] See article 72, 106, 107 Basic Constitutional Law of the Federal Republic of Germany.
[4] Source: Swiss Federal Department of Finance, www.nfa.ch. Fischer et al. (2003) give an overview on the reform of the Swiss equalization schemes.

cantons. The EU also has a strong redistribution policy. During the budgetary period 2007-2013 the investment made by the EU through cohesion instruments will be worth 308 billion Euro, which is roughly 36% of its entire budget (862 billion Euro). [5]

The aim of this paper is to investigate both theoretically and empirically the impact of interregional transfers on regional disparities within federations. We first present a basic model where people migrate between regions as to maximize personal utility, which depends on wages and public policy. We show that without federal equalization payments, people migrate from poor regions to richer ones promoting convergence of regions in respect to GDP per capita, wages, consumption, taxes and the level of public goods provided. This is the well-known phenomenon of 'the poor chasing the rich' and in line with the neo-classical growth theory [see Barro and Sala-i-Martin (1992).]. In contrast, if the federal government tries to redistribute between rich and poor regions via equalization payments, the individual migration decision gets distorted. Under these circumstances the convergence process gets paralyzed and existing disparities are cemented. We test our theoretical findings using cross-section as well as panel data for 23 OECD countries covering the period from 1982 to 2000. The evidence suggests a positive relationship between interregional transfers and regional disparities, both across countries and over time. In the cross-section data, we find that countries with higher levels of interregional redistribution in the past show a subsequent increase in regional disparity, while countries with lower levels of grants and transfers show less divergence or even convergence. The panel reveals a similar picture: countries who have increased their sub-governmental transfers and grants have experienced more divergence (less convergence) over time than countries who have lowered their transfers.

The remainder of the paper is organized as follows. In Section 2 we present a theoretical model illustrating that interregional transfers do not necessarily promote convergence. We provide empirical evidence for these negative redistributional effects in Section 3. In Section 4 we discuss our theoretical and empirical findings in relation with the literature. In a concluding Section 5 we sum up our results and we give an outlook on future work.

[5] Source: European Commission, Financial Programming and Budget, http://ec.europa.eu/budget/.

2 A Model of Migration, Equalization Payments, and Convergence

Although most federations make use of equalization transfer schemes, it is not per se clear in how far such payments are appropriate to diminish regional disparities. We argue that intergovernmental transfers distort individual migration decisions, and can be therefore the reason for persisting regional inequalities. This section develops a basic analytical framework to study the channels through which regional disparities are affected by equalization transfers and population movements, and how these channels interact. The model is primarily meant to illustrate the main argument; rather than aiming for generality, we therefore confine ourselves to a simple general equilibrium economy, augmented by a public sector. The reader can easily convince himself, though, that the line of reasoning would remain qualitatively unchanged in a more intricate framework.

Consider a federation or a country consisting of $j = 1, 2$ regions, inhabited by a continuum of mobile households i who reside on the closed interval $[0, 1]$, where i represents their initial location. The border is located at $i = \bar{n}_1 = 1 - \bar{n}_2$ so that all households $i \in [0, \bar{n}_1]$ initially live in region 1 whereas households $i \in (\bar{n}_1, 1]$ are initial residents in of region 2. When emigrating from its home region, households incurs different migration cost m^i, which we assume to be proportional to their distance from the border, $m^i = \theta(\bar{n}_1 - i)$ for $i \leq \bar{n}_1$ and $m^i = \theta(i - \bar{n}_1)$ otherwise where $\theta \geq 0$ measures the cost of mobility.[6] By definition, $\bar{n}_j$ is region j's share of the total population. Households supply one unit of labor inelastically wherever they live, and have identical preferences over a composite consumption good c and a local public good g represented by a strictly increasing, twice differentiable, and concave utility function $U(c, g)$. We also assume $U(\cdot)$ to be homothetic.[7]

In each region, competitive firms produce c according to a strictly increasing, concave, and constant returns to scale production function $Y_j = F(n_j, \bar{K}_j)$, where n_j is the equilibrium labor force of (the mass of households living in) region j, and $\bar{K}_j$ is a fixed, immobile factor of production such as infrastructure, natural resources, land, entrepreneurial input, or non-transferable know-how. We assume that K_j is owned

[6] Equivalently, these migration costs can be interpreted as representing an 'attachment to home' (individuals have locational preferences for their home region due to cultural differences) by assuming that individual utility is given by consumption c^i, plus a non-pecuniary element m^i [see, e.g., Mansoorian and Myers (1993)].

[7] The homotheticity assumption is much stronger than is necessary but shortens the analysis and exposition considerably.

(supplied) by absentee households for simplicity,[8] and that the cross-derivative of F are positive, i.e., additional use of one factor of production increases the marginal productivity of other factors. The first-order conditions of profit maximization imply that each factor is paid its marginal product and that profits are zero (subscripts denote derivatives)

$$\begin{aligned} w_j &= F_n(\bar{K}_j, n_j) = f_n(k_j) \qquad \text{and} \quad r_j = F_K(\bar{K}_j, n_j) = f_k(k_j) \\ Y_j &= F(\bar{K}_j, n_j) = r_j \bar{K}_j + w_j n_j \quad \Leftrightarrow \quad y_j = f(k_j) = w_j + r_j k_j \end{aligned} \tag{1}$$

where $k_j = \bar{K}_j / n_j$ and $y_j = Y_j / n_j = f(k_j)$. Note that the technology $F(\cdot)$ is identical across regions, i.e., any (initial) productivity differences can solely be attributed to differences in the regions' (initial) factor endowments.

Regions decide on their local public good provision g_j, which they finance by a proportional tax t_j on the income of their residents. To abstract from congestion effects, let the cost of providing a unit of the public good to one more resident be constant and without loss of generality equal to one (g_j is a publicly provided private good). Although local policies (t_j, g_j) are chosen independently in each region, regions may be linked financially through horizontal transfers $T_j \in \mathbb{R}$ to be received or paid by region j. The size of these interregional grants is determined by the federal government *prior* to local policies decisions in a manner that is made precise below. For the moment, we take T_j as an exogenously given lump sum transfer to (or from) region j and only require $\sum_j T_j = 0$ so that the federal budget is always balanced. The local budget constraint in per capita terms, which defines the set of feasible policies in region j, reads

$$g_j = t_j w_j + T_j / n_j, \qquad j = 1, 2. \tag{2}$$

Using (2), the indirect utility of a household residing in region j can be written as

$$U(g_j, w_j) = u(w_j - g_j + T_j / n_j, g_j). \tag{3}$$

Given the fiscal constitution, the sequence of events is as follows. In stage 1, households decide where to live so as to maximize their utility, taking regional factor incomes as given and anticipating the public policy in each region. In stage 2, regional governments choose g_j, households collect their after tax income, and consume.[9]

[8] Alternatively, the fixed factor could be publicly owned as in Boadway and Flatters (1982). However, the migration equilibrium in this case is generally inefficient, which complicate matters without changing the main result.

[9] Assuming that policies are determined *after* residential choices have been made allows

Equilibrium Analysis

Solving the model backwards, the stage 2 decision on local public good provision in region j maximizes the indirect utility of a representative household (3) residing in that region. The corresponding first-order conditions equate the marginal rate of substitution between the private and the public good to the marginal rate of transformation,

$$\frac{u_g(c_j, g_j)}{u_c(c_j, g_j)} = 1 \qquad \text{or} \qquad \frac{u_g\left(\frac{c_j}{g_j}, 1\right)}{u_c\left(\frac{c_j}{g_j}, 1\right)} = 1, \qquad j = 1, 2 \tag{4}$$

where the second equality follows from our assumption that preferences are homothetic. Together with $c_j = w_j - g_j + T_j/n_j$, condition (4) defines the level of local public goods supplied in region j as a function of average income w_j, inter-regional transfers T_j, and population size n_j. Turning to stage 1 migration decisions, note first that they depend on individual mobility cost, as well as on the inter-regional differences in wages and public policies. Because the costs of moving are monotonic, a migration equilibrium can be characterized by a marginal household i^* who is indifferent between residing in either region, with all households $i \leq i^*$ (respectively, $i > i^*$) living in region 1 (respectively, region 2). Regional populations are

$$n_1 = \int_0^{i^*} di = i^* \quad \text{and} \quad n_2 = \int_{i^*}^1 di = 1 - i^*,$$

and the migration equilibrium condition can be written as

$$u(c_1, g_1) = u(c_2, g_2) - \theta(\bar{n}_1 - n_1) \tag{5}$$

which, using (3) and $n_1 + n_2 = 1$, determines regions j's labor force (population size) as a function of w_j, $\bar{n}_j$ and g_j.

Equilibria without Equalization

As a benchmark, let us first study the case where households are immobile ($\theta \to \infty$) and the federal government imposes no equalization transfers ($T_1 = T_2 = 0$). Assume without loss of generality that $k_1 = K_1/\bar{n}_1 > K_2/\bar{n}_2 = k_2$, i.e., region 1 enjoys a higher per-capita endowment of the fixed factor. Using $y_j = f(k_j)$ and (1), this endowment difference will translates into higher regional per-capita GDP and higher

us to disregard tax competition effects (migration-induced fiscal externalities) between regions. The sequential model here is equivalent to the assumption that public policy is chosen simultaneously to households' migration, factor supply, and consumption decisions, but regional governments do not foresee migration responses to their political choices.

wages in region 1, $y_1 > y_2$ and $w_1 > w_2$. At the same time, region 1 will be providing more public services at lower taxes. Substituting for $c_j = w_j - g_j$ in (4), we find

$$\frac{\partial g_j}{\partial w_j} = \frac{u_{cc} - u_{cg}}{u_{cc} - 2u_{cg} + u_{gg}} \in (0,1) \quad \text{and} \quad \frac{\partial t_j}{\partial w_j} < 0,$$

where the second inequality follows from $g_j = t_j w_j$ [see (2)] and the fact that $\partial g_j / \partial w_j < 1$. We can thus conclude:

Observation 1 *Consider a federation with immobile households ($\theta \to \infty$) and no fiscal equalization ($T_1 = T_2 = 0$), and assume w.l.o.g. $\bar{k}_1 = \bar{K}_1/\bar{n}_1 > \bar{K}_2/\bar{n}_2 = \bar{k}_2$. An equilibrium in this economy is then characterized by*

$$\bar{y}_1 > \bar{y}_2,\ \bar{w}_1 > \bar{w}_2, \bar{c}_1 > \bar{c}_2, \quad \textit{and} \quad \bar{g}_1 > \bar{g}_2,\ \bar{t}_1 < \bar{t}_2. \tag{6}$$

In other words, regions with a higher initial per-capital endowment of the fixed factor (higher labor productivity) will display higher per-capita GDP and wages, provide more public services and impose lower taxes in equilibrium than regions with lower initial per-capita endowments of the fixed factor (lower labor productivity).

How does labor mobility affect this equilibrium? If we continue to assume that no equalization payments are made, the higher wages in region 1, coupled with lower taxes and higher public good supply, will induce low-migration cost households to emigrate from region 2 into region 1, increasing the size of the labor force in the latter region. The immigration will continue to the point where (5) is satisfied with equality. Analogous to our previous arguments, the influx of labor will depress wages, reduce public good provision and raise taxes in region 1, while the opposite happens in region 2. The result is regional convergence: disparities in wages, net incomes, per-capita GDP, and public policies are diminished. Moreover, the effect is stronger the lower the migration cost.

Observation 2 *Consider an equilibrium in a federation with mobile households ($\theta < \infty$) and no fiscal equalization ($T_1 = T_2 = 0$) satisfying (6). As individual mobility cost decline to $\theta' < \theta$, the new equilibrium is characterized by*

$$y_1' < y_1,\ w_1' < w_1,\ c_1' < c_1 \quad \textit{and} \quad g_1' < g_1, t_1' > t_1$$

and

$$y_2' > y_2,\ w_2' > w_2,\ c_2' > c_2 \quad \textit{and} \quad g_2' > g_2, t_2' > t_2.$$

As households become perfectly mobile, $\theta \to 0$, all regional disparities vanish and we have $y_1 = y_2$, $c_1 = c_2$, $w_1 = w_2$ and $g_1 = g_2$.

As the argument behind this result is straightforward but tedious, we omit a full-fledged formal proof and only sketch the line of reasoning. To show for instance that public and private consumption must fall in region 1, suppose to the contrary that $c_1' > c_1$. But then $g_1' > g_1$ by (4), which in turn implies $L_1' > L_1$ from (5). Hence, $w_1' < w_1$ contradicting our assumption that $c_1' = w_1' - g_1' > w_1 - g_1 = c_1$. Thus, we must have $c_1 <' c_1$.

Equilibria with Equalization

Let us now turn to the case where $T_1 = -T_2 \neq 0$. In many federations, such transfers play the role of explicit 'equalization payments' from the federal government to state or provincial governments with the objective of offsetting differences in available revenue or in the cost of providing services. [10] As mentioned above, we will assume the T_j's are set by a federal government prior to regional policies. In other words, local governments treat T_j as exogenously given, while the federal government correctly anticipates how local policies (t_j, g_j) vary with T_j. [11] A system of full fiscal equalization providing the average level of public goods in each region. In a system of partial equalization, only a fraction β of revenues are equalized. Define $R = t_1 n_1 w_1 + t_2 n_2 w_2$ as the average tax revenue in the federation. A transfer scheme

$$T_j/n_j = \beta(R - t_j w_j) \quad \Rightarrow \quad g_j = \beta R + (1-\beta) t_j w_j, \qquad j = 1, 2. \tag{7}$$

pays each region a fraction of the difference between average public revenues and regional public revenues in per-capita terms, and will result in full (partial) equalization if $\beta = 1$ ($\beta < 1$). Note from (4) that full equalization in terms of public expenditures, $g_1 = g_2$, also implies full equalization in terms of private consumption. Intuitively, since the (politically decisive) households in each region share the same marginal rate of substitution between private and public goods, they would want to consume the same amount of private goods whenever they also consume the same amount of local public goods under the equalization system. As a result, the local political process in stage 2 yields to adjusted regional tax rates ensuring $c_1 = (1 - t_1)w_1 = (1 - t_2)w_2 = c_2$. Importantly, however, transfer payments cannot do more than that. In particular, they cannot serve to equate regional differences in GDP or wages: those variables are still determined by the market, and since the regional factor endowments remain unchanged, so do regional output and factor

[10] Examples of federal systems with explicit equalization payments include Australia, Belgium, Canada, Germany, and Switzerland.

[11] If regions foresee the effect of regional policies on grants, regional governments in the recipient (respectively, donor) region would have an incentive to strategically manipulate (t_j, g_j) in order to increase (respectively, decrease) the net transfer [see, e.g., Smart (2007).]

prices. In summary,

Observation 3 *Consider an equilibrium in a federation with immobile households ($\theta \to \infty$) that satisfies* (6)*. If the federation puts a system of transfers* (7) *in place, the new equilibrium for $\beta = 1$ (full equalization) will be characterized by*

$$y_j = \bar{y}_j,\ w_j = \bar{w}_j, \bar{c}_1 > c_1 = c_2 > \bar{c}_2, \quad \textit{and} \quad \bar{g}_1 > g_1 = g_2 > \bar{g}_2,\ t_1 > \bar{t}_1, t_2 < \bar{t}_2.$$

For $\beta < 1$ (partial equalization), we have y_j and w_j unchanged, and partial convergence in public and private consumption, $g_1 - g_2 < \bar{g}_1 - \bar{g}_2$ and $c_1 - c_2 < \bar{c}_1 - \bar{c}_2$.

A comparison of Observation 2 and 3 reveals that the channels of domestic migration and fiscal equalization are substitutes in driving inter-regional convergence, albeit imperfect ones. While inter-regional migration leads to convergence of both regional consumption *and* factor prices/regional output, inter-regional transfers only affect the former and are not suitable to reduce regional disparities in factor prices and output.

It remains to study how the two channels interact, i.e, how equalization and migration work together. At first glance, one may be tempted to conclude that the qualitative implications of either effect remain intact, implying for instance that perfect mobility still serves to effectively eliminate any existing disparities. This is no longer the case, however, as can be seen from (5). If fiscal equalization equates public and private consumption, we have $c_1 = c_2$ and $w_1 = w_2$. Thus, equalization makes all incentives to migrate disappear, thereby cementing the regional differences in factor prices and GDP.

Observation 4 *Consider an equilibrium in a federation with mobile households ($\theta < \infty$) and a system of transfers* (7) *in place, the new equilibrium for $\beta = 1$ (full equalization) will be characterized by*

$$y_j = \bar{y}_j,\ w_j = \bar{w}_j, \bar{c}_1 > c_1 = c_2 > \bar{c}_2, \quad \textit{and} \quad \bar{g}_1 > g_1 = g_2 > \bar{g}_2,\ t_1 > \bar{t}_1, t_2 < \bar{t}_2.$$

Although we are aware of the simplicity of our model, it shows that there is reasonable doubt that equalization payments help poor regions to catch up with the richer ones. Anecdotal evidence for example of the Italian Mezzogiorno or parts of East Germany imply, that even the trillions of Euro spend over decades for the structural change in those backward regions where not able to promote regional growth and convergence. However, the following section provides a direct test of the impact of interregional transfers on regional disparity.

3 Empirical analysis

The main hypotheses

Our theoretical model suggests that interregional transfers do not promote convergence, quite the contrary. We can accordingly state our two main hypotheses:

Hypothesis 1 *Countries with a high level of interregional transfers face divergence instead of convergence.*

Hypothesis 2 *An increase in the amount of interregional transfers leads to an increase in regional disparities.*

We test these hypotheses using cross-section as well as panel data for 23 OECD countries covering the period 1982-2000. As the measurement of regional disparities and interregional transfers is a challenging topic, we discuss our data in the following section in details before we subsequently present our estimation results.

Data description

To test our hypotheses derived from the theoretical model, we need adequate measures for regional disparities as well as grants and transfers. First, we turn to the measurement of regional disparity as our dependent variable. Various measurement concepts for disparities are used in the literature. Three different problems arise while measuring disparity: first, we have to choose an appropriate economic indicator as basis for the calculation. Second, we must define the territorial level. Third, we must select an applicable concentration measure. [12]

Our model suggests, that interregional equalization payments cement regional output disparities. Hence, we choose the regional gross domestic product per capita (GDP p.c.) as basic economic indicator. This is not only in line with our theoretical model but also with the measurement concept of regional disparities in the OECD Territorial Outlook 2001. [13] Nevertheless, we should mention that outher authors as e.g. Shankar and Shar (2003) or Gil Canaleta et al. (2004) rely on the income per capita or the GDP per worker as basis for the calculation of regional disparities in other backgrounds.

[12] For a detailed discussion of the problems arising when measuring regional disparity, see Lessmann (2006), pp. 9-12 and Spieza (2003).
[13] See OECD (2001).

A second problem arises from the different sizes of the regions considered. An example should illustrate this problem: assume a two region country with one region with 1,000 inhabitants and a GDP p.c. of 20,000 Euro. The second region has a GDP p.c. of 10,000 Euro but only 10 inhabitants. Without taking the different population size into account, a disparity measure would show a high disparity, although the disparity does not affect many people. Therefore, it is necessary to use a territorial classification with relatively homogeneous regions. We solve this problem by using the NUTS 2 classification within Europe, which uses widely homogeneous regions with a minimum of 800,000 and a maximum of 3,000,000 inhabitants. For outside European countries we consider state level data.

The third question to be discussed is which concentration measures are applicable for the measurement of regional disparities. Different measures of inequality do not always provide the same country disparity ranking. [14] There are different requirements a measure has to satisfy, especially in cross-country comparisons. Firstly, the measure should be independent of the number of regions considered, and secondly, the measure should be non-sensitive to shifts in average GDP p.c. levels. Often used disparity measures include the standard deviation, the standard deviation of the natural logarithm, the coefficient of variation, the adjusted Gini coefficient, the Herfindahl Index, and the Theil Index of inequality. All these measures represent the concentration of GDP p.c. within a country and satisfy the Pigou-Dalton transfer principle, that is, an arithmetical transfer from richer to poorer regions reduces inequality. [15] Since some of these measures depend on the number of regions or the average GDP p.c levels, they are not appropriate for the aim of this paper. Appropriate disparity measures satisfying these requirements are the coefficient of variation (COV) and the adjusted Gini coefficient (ADGINI). [16] We calculate both measures for 23 highly developed OECD countries for the period 1982 to 2000 using data of national statistical offices. Table 1 shows the results for two different periods.

[14] For a comparison of different disparity measures see Spieza (2003), OECD (2003), and Lessmann (2006).
[15] See Dalton (1920) and Pigou (1912).
[16] See Appendix A for the underlying equations.

Table 1
Regional disparity in OECD countries

	Disparity measures			
	Coefficient of variation		Adjusted Gini coefficient	
Countries	1982-1986	1996-2000	1982-1986	1996-2000
Austria	22.5	20.1	14.6	12.6
Belgium	39.8	37.3	18.8	18.9
Canada	25.6	22.0	15.6	13.8
Czech Republic		38.2		16.4
Denmark	10.9	10.9	8.8	8.5
Finland	13.5	18.4	7.3	11.1
France	16.9	18.8	7.6	7.5
Germany	17.9	19.3	9.5	10.2
Hungary		28.9		18.3
Ireland	11.5	19.3	11.0	19.0
Italy	24.3	25.1	14.9	15.4
Japan		19.4		9.1
Mexico		45.5		26.1
Netherlands[a]	25.4	16.5	13.6	10.0
Norway	14.8	13.3	9.8	7.5
Portugal	26.2	19.6	14.2	12.0
Poland		18.9		10.5
Slovakia		53.2		27.2
Spain	21.1	19.9	12.6	12.1
Sweden	7.5	13.5	4.2	6.5
Switzerland	10.7	13.9	6.9	7.8
UK	25.4	29.0	10.4	12.9
USA	38.6	32.0	14.7	12.5
Average	20.8	21.3	11.5	12.1

Note: a) The disparity measures for the Netherlands refer to 1986 because of an reorganization in the NUTS classification.

Source: Own calculations from data of national statistical offices.

Especially for the Scandinavian countries as well as Switzerland, the coefficient of variation indicates a disparity far below average. In contrast, the countries with a very high regional disparity are Slovakia, Mexico, and Belgium. These results also hold for the adjusted Gini coefficient.[17] Focusing on the development over the two periods, the overall average degree of regional disparity was quite stable. However, disparities within countries developed differently – in some countries regions con-

[17] The correlation coefficient between COV and ADGINI is 0.87.

verged while regions diverged in others. [18]

Besides adequate measures for regional disparity we need the level of vertical and horizontal grants within the considered countries. For this purpose we revert to data of the IMF *Government Finance Statistics* and the OECD *Revenue Statistics*. Our main explanatory variable of interest is TRANS1, which are grants received by sub-national governments from other levels of government (without grants from abroad or supra-national institutions) as share of total government revenues. As this measure covers all grants from other levels of government, it reflects the extent of vertical as well as horizontal equalization. To check for the robustness of our results, we also consider an alternative measure, TRANS2, which denotes sub-national non-autonomous revenues as share of total government revenues (adjusted for sub-national transfers to other government levels). The calculation of this measure is more sophisticated as we need to know which sub-national revenues are determined autonomously. The necessary information contains the OECD Tax Policy Study No. 1 , which classifies all tax revenues in respect to the control different government levels have over their revenue sources. [19] Using this framework, we calculate the share of non-autonomous revenues of sub-national governments as a share of total government revenues obtaining our TRANS2 measure. [20] In contrast to the TRANS1 measure, TRANS2 also covers sub-national revenues from composite and shared taxes, respectively.

In order to minimize possible omitted variable bias on the coefficient of our transfer measure, we include in our regressions a number of controls that have been shown to have an impact on regional disparity in the literature. One of these controls is the nations' wealth reflected by the GDP per capita (GDPPC), because the richer a country the higher the scope for redistributive politics through other transmission channels than interregional grants and transfers. Moreover, we control for the unemployment level (UNEMPL), since unemployment is often locally concentrated and might thus affect our disparity measure. Following the suggestions of Kuznets (1955) we consider the population size (POP), the population distribution within

[18] Our disparity measures reflect the distribution of per capita GDP within countries. This is in accordance with the concept of *sigma*-convergence first mentioned by Easterlin (1960). See e.g. Barro and Sala-i-Martin (1991), Barro and Sala-i-Martin (1992), Barro and Sala-i-Martin (1995), or Quah (1993) for details. *Sigma*-convergence means that the dispersion of income (or in our case GDP per capita) between regions declines. This is not necessarily a consequence of *beta*-convergence meaning that poor regions catch up with richer ones.

[19] See OECD (1999) and Stegarescu (2005) for details.

[20] See Appendix B for details of these calculations.

a federation (POPGINI), and the degree of urbanization (URBAN) as controls for agglomeration. The total population is our control variable for the country size. The Gini coefficient of the population concentration (POPGINI) reflects the extent of agglomeration within a country. It has unsurprisingly the highest value for Canada (average 0.63) and the lowest value in the Czech Republic (average 0.07), where the population is nearly uniformly distributed over the sub-national jurisdictions. The degree of urbanization is also a control for agglomeration effects, although it reflects a different kind of agglomeration compared to the POPGINI variable. While the degree of urbanization can be high within a country, meaning that many people live in urban instead of rural areas, that does not necessarily signify that the urbanization varies across sub-national jurisdictions. In the latter case, we would not expect a larger effect on our disparity measure. And indeed, POPGINI and URBAN reflect different kinds of agglomeration indicated by a correlation coefficient of -0.07 which is insignificant on conventional confidence levels. With the government expenditures on public welfare as a share of GDP we control for the size of the welfare state (SOCIAL). If, for example, regions are heterogeneous in respect to productivity, unemployment etc., then we would expect that the inhabitants of richer regions are over all net contributors to the social security funds, while people in poor regions receive net transfers. Thus, one can expect that countries with a big welfare state have a strong indirect territorial redistribution system. Last but not least, we control for the degree of expenditure decentralization (DEC): On the one hand, decentralization might soften central governments power to redistribute between regions [Prud'homme (1995)], on the other hand, decentralization might serve as a commitment device enhancing poor regions effort to catch up to the richer ones [McKinnon (1995), Qian and Weingast (1997)]. Table 2 provides summary statistics for the relevant variables.

Table 2
Summary statistics, panel data

Variable	Mean	Std. Dev	Min	Max
COV	.207	.081	.071	.420
ADGINI	.119	.037	.040	.194
TRANS1	.132	.052	.016	.245
TRANS2	.155	.100	-.077	.461
GDPPC (1.000 $)	17.596	5.119	6.810	30.913
UNEMPL	.086	.044	.008	.229
POP (Mill.)	36.848	61.470	3.504	275.168
POPGINI	.375	.127	.173	.635
URBAN	.745	.123	.389	.972
SOCIAL	15.833	3.581	9.833	26.333
DEC	.383	.146	.091	.700

Cross-section results

A major problem for our empirical analysis is the availability of regional data, which is necessary for the computation of our disparity measures. Furthermore, we need information for a long time period, because we are interested in the dynamics of convergence or divergence within federations, not just in disparity levels. This restricts our cross-section analysis to a small sample of 23 countries. [21] In the panel analysis, however, the data problems are less eminent, because we can revert to annual data for 17 countries.

Our specification for the test of Hypothesis 1 in our cross-section OLS regressions is

$$\begin{aligned}\Delta\text{DISPARITY}_i = \beta_0 + \beta_1 \cdot \text{TRANSFERS}_i + \beta_2 \cdot \text{INITIAL DISPARITY}_i \\ + \sum_{j=3}^{k} \beta_j \cdot \text{CONTROL}_{i,j} + \varepsilon_i\end{aligned}$$

[21] The considered countries are: Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Hungary, Ireland, Italy, Japan, Mexico, the Netherlands, Norway, Poland, Portugal, Spain, Slovakia, Sweden, Switzerland, the United Kingdom, and the USA.

The dependent variable ΔDISPARITY$_i$ is the change of the disparity measure in our whole observation period 1982 to 2000. Our main explanatory variable of interest is the transfer variable (TRANS1). Moreover, we control for the initial disparity level, the GDP p.c. (GDPPC), and the unemployment ratio (UNEMPL). Table 3 reports coefficients from OLS estimation with White (1980) corrected standard errors. To address the issue of potential reverse causality between the dependent and independent variables, our transfers measure is an average of the 1980s, and thus only from a part of our whole observation period. [22]

Table 3
Cross-section estimations

	Dependent variable:			
	ΔCOV		ΔADGINI	
TRANS1	.460	*	.278	***
	(2.04)		(2.64)	
INITIAL DISPARITY[a]	-.208	***	-.182	*
	(-2.66)		(-1.85)	
GDPPC	-.012	***	-.007	***
	(-2.99)		(-3.81)	
UNEMPL	-.625		-.164	
	(-1.55)		(-1.22)	
Constant	1.249	***	.120	***
	(2.81)		(3.09)	
Obs	22		22	
Adj.-R^2	.26		.47	
F-Test (p-value)	.002		.004	

Note: t-values in parenthesis; ***, **, and * indicate significance at 1%, 5%, and 10%, respectively.

a) INITIAL DISPARITY reflects COV_{1982} for the first, and $ADGINI_{1982}$ for the second specification.

Our measure of transfers enters the regressions with a positive sign and is significant at conventional confidence levels (10% and 1% respectively). This indicates that countries with a high level of equalization payments have diverged, while countries with a lower transfer level experienced convergence. In both specifications, the initial level of regional disparities has a negative impact on the change in disparities. The GDP p.c. as measure for nations' wealth shows that richer countries experienced convergence, while the unemployment ratio has a negative but insignificant impact. The estimations explain up to 50% of the variation in the change in our disparity measures.

[22] Averages of our transfer measure for the whole observation period lead to similar results. The results are available on request.

Although these results support our *Hypothesis 1* of the uselessness of interregional transfers to achieve convergence, we are aware of the problems coming from our small sample size. Therefore, we repeat these estimations with a larger panel data set.

Panel evidence

Due to the much larger number of observations in our panel data set, [23] we are able to consider all of our control variables. The time series data also allow for analyzing a dynamic relationship between interregional transfers and regional disparities testing *Hypothesis 2*. The estimation equation now takes the form

$$\begin{aligned}\text{DISPARITY}_{i,t} = \beta_{0i} &+ \beta_1 \cdot \text{TRANSFERS}_{i,t} + \beta_2 \cdot \text{GDPPC}_{i,t} + \beta_3 \cdot \text{UNEMPL}_{i,t} \\ &+ \beta_4 \cdot \text{POP}_{i,t} + \beta_5 \cdot \text{POPGINI}_{i,t} + \beta_6 \cdot \text{URBAN}_{i,t} \\ &+ \beta_7 \cdot \text{SOCIAL}_{i,t} + \beta_8 \cdot \text{DEC}_{i,t} + \beta_9 \cdot \text{T}_t + \varepsilon_{i,t}\end{aligned}$$

where β_{0i} captures the country specific fixed effects, and β_9 captures time specific effects. [24] To get rid of business cycle effects, we build three-year period averages of all variables from 1982 to 1999. Several unit root tests as Levin, Lin and Chu test, Im, Pesaran and Shin W-statistics, Augmented Dickey-Fuller test statistic, and Phillips-Perron Fisher unit root test negate the hypothesis of the existence of non-stationary time-series, individual or common unit roots. Furthermore, the Hausman (1978) specification test rejects models using random effects; hence, we choose the country fixed effects model as econometric specification. Table 4 reports the estimation results for the coefficient of variation (COV) as disparity measure. [25]

[23] As long time series data are not available for all countries in our cross-section analysis, we end up with 17 OECD countries: Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, and the USA.

[24] Variable POP enters the regressions in logarithms.

[25] See Appendix C Table A2 for a robustness test using the adjusted Gini coefficient (ADGINI) as dependent variable.

Table 4
Panel estimations

	Dependent variable: COV			
	OLS	OLS	TSLS	TSLS
	(1)	(2)	(3)	(4)
TRANS1	.232**		.129	
	(2.37)		(.36)	
TRANS2		.235***		.186**
		(3.47)		(2.55)
GDPPC	.011***	.009***	.013***	.012***
	(3.86)	(2.78)	(6.11)	(6.25)
UNEMPL	.466***	.423***	.406***	.315**
	(3.81)	(3.54)	(4.19)	(2.48)
POP	-.436***	-.457***	-.388***	-.518***
	(-6.41)	(-6.82)	(-3.37)	(-7.00
POPGINI	1.607***	1.507***	1.728	2.530***
	(2.67)	(2.99)	(1.19)	(3.25)
URBAN	-.300*	-.299*	-.307	-.129*
	(-1.80)	(-1.92)	(-1.55)	(-1.82)
SOCIAL	-.001	-.001	-.001	-.002
	(-.92)	(-1.23)	(-0.78)	(-1.64)
DEC	-.354***	-.347***	-.181*	-.179*
	(-2.70)	(-2.63)	(1.71)	(-1.94)
Country Dummies	Yes	Yes	Yes	Yes
Time Dummies	Yes	Yes	Yes	Yes
Obs	17 (92)	17 (91)	17 (77)	17 (74)
Adj.-R^2	.94	.94	.96	.97
F-Test (p-value)	.000	.000	.000	.000
Sargan-Hansen statistic	–	–	.000	.000

Note: t-values in parenthesis; ***, **, and * indicate significance at 1%, 5%, and 10%, respectively.

The first two specifications are two-way fixed effects OLS estimations with our alternative TRANS1 and TRANS2 measures.[26] In specification (3) and (4) we present results from the TSLS estimation procedure using a one period (3-year) lagged value of the transfer measure as instrument. The Sargan-Hansen statistic implies that our instruments are valid. Note that in contrast to the cross-section estimations we now use levels of the disparity measure in combination with country fixed effects focusing on the within country variation. In the OLS estimations of column (1) and (2)

[26] We do not report coefficients of the country and time dummies due to space limitations.

both transfer measures have a positive and significant impact on regional disparities indicating that a high level of interregional redistribution leads to high regional disparities. For the TRANS2 measure, this result also holds for instrumental variable estimations to tackle the problem of a possible endogeneity bias. In the TSLS estimation of column (3), TRANS1 has no significant impact on regional disparity. The same result occurs, if we use ADGINI as dependent variable, indicating that high transfers have no impact on regional disparities or even cause divergence (see Appendix C Table A2).

We now turn to the interpretation of our control variables. GDPPC has a positive and highly significant impact on regional disparities as well as the unemployment ratio (UNEMPL). Larger countries in terms of POP develop smaller disparities, whereas an unequal population distribution (POPGINI) is associated with a high level of regional disparities. In contrast, the degree of urbanization (URBAN) has a negative and weakly significant impact on our disparity measure. The size of the welfare state (SOCIAL) shows no significant effects, while decentralization (DEC) has a significant negative impact on regional disparity supporting the results of earlier studies.[27] All in all, our estimation results support *Hypothesis 2* and, thus, our theoretical model.

4 Discussion

The growth literature has long recognized that the speed of convergence can be quickened by migration. In a standard neo-classical growth framework, regions with higher capital–labor ratios are predicted to grow faster in per capita terms than regions with lower capital–labor ratios. This process should be accelerated by migration as people move from areas of low productivity to areas of high-productivity in order to enjoy higher wage rates [Barro and Sala-i-Martin (1992).] Thus, we would expect a positive relationship between net migration and the speed of convergence. Our theoretical model shows that if moving was costless, migration alone is sufficient to equalize per capita incomes instantaneously according to the neo-classical theory under some straightforward conditions (see *Observation 2*). In practice, of course, moving entails costs. In such a situation, migration does not generally result in full convergence.

Although wages, unemployment rates, and migration cost are undoubtedly impor-

[27] See e.g. Rodríguez-Pose and Gill (2004), Gil Canaleta et al. (2004) or Lessmann (2006).

tant, there are other factors that influence an individual's decision to move. In particular, a natural determinant of migration are regional variations in the public policy sphere that manifest themselves as differences in fiscal capacity, pubic expenditures, unemployment subsidies and tax rates. [28] If migration is in part a response to those differences, its positive effect on allocative efficiency can no longer be taken for granted because movement of labor may be triggered by differences in fiscal policies which do not necessarily reflect underlying differences in the marginal product of labor. This perspective is often taken in the public finance literature. [29] In such a situation interregional transfers can serve as an instrument to control migration, as noted by Boadway and Flatters (1982) and Fernandez and Rogerson (1996). The basic idea here is that the federal government can use these transfer payments in a way similar to Pigouvian taxes and subsidies, i.e., in order to induce regions to internalize migration-induced (fiscal) externalities. This view is limited, however, in the sense that the notion of transfers as an instrument for horizontal equity is entirely absent. To understand whether or not they might be appropriate for that purpose, one also has to bring the relationship between migration and convergence into the picture. This is what we do in our model. We find that equalization payments inhibit migration and thus inhibit regional convergence (see *Observation 4*).

The paradoxical situation that interregional transfer payments sustain interregional inequalities is also discussed by other authors. Feld and Dede (2005) argue, that on the one hand, grants could give underdeveloped regions the scope they need for investments in infrastructure and human capital. On the other hand, it is doubtful whether they use transfers effectively. Instead of investing in growth stimulating factors, grants are used for consumption and to subsidize the inefficient local industry. Hence, the necessary structural change becomes paralyzed and the economic backwardness is sustained. This view is supported by Rodden (2003) who empirically analyzes the impact of vertical grants on federal and sub-national government

[28] While there is strong empirical evidence that internal migration depends on relative incomes and unemployment rates [Barro and Sala-i-Martin (1991), Barro and Sala-i-Martin (1992)], the evidence on the relative importance of other factors such as tax rates and income support programs is more scattered. Using Canadian data, Day (1992) and Shaw (1986) find evidence that internal migration in Canada is influenced by provincial differences in income tax rates, transfer payments to persons, unemployment insurance programs, and natural resource revenues.

[29] One prominent example is the literature on tax competition, which shows that the competition for a mobile common tax base leads countries to implement tax rates below the cooperatively chosen level [see Wilson (1999) for a survey]. An alternative interpretation of this inefficiency is that countries do not internalize a migration-induced fiscal externality they exert on their neighbors by changing domestic taxes.

growth. He finds strong support for the 'flypaper effect' that 'money sticks where it hits': the higher the level of grants, the faster the growth of sub-national governments [see also Hines and Thaler (1995)]. Obviously, sub-national governments act as Leviathans and consume grants instead of using them for tax cuts or other growth stimulating factors. In light of this it is not straightforward to assume that equalization payments promote regional convergence.

Closely related to our work is the study by Hansen and Kessler (2006) who analyze the effects and the determinants of interregional redistribution in a model of residential and political choice. In a much more sophisticated framework than ours, they find that with inter-jurisdictional redistributive transfers, regions not only differ in their local equilibrium policies, but also diverge with respect to per capita incomes: high-income households live in one region and low-income households in the other. Thus, interregional redistribution cements regional disparity.

As mentioned above the whole public policy sphere influences individuals decision to move. Sinn and Ochel (2003) analyze the impact of harmonization of social standards on convergence within the European Union. If the EU forces all member states to implement minimum social standards, as e.g. replacement incomes, than rich and poor regions are affected differently. While rich regions will have less problems with a certain economically justifiable level of replacement incomes, harmonization at a level appropriate for the rich that is binding for the poor regions is likely to result in mass unemployment in the latter. Moreover, people do not emigrate to the rich regions since the replacement incomes act as stay-put premia and prevent convergence promoting migration. The effect of such social transfers – be they paid by other jurisdictions as interregional transfers or are all jurisdictions forced by law to pay them on their own – has comparable negative redistributive effects as equalization grants in our analysis.

As in the case of our theoretical model, also our empirical results find support in the literature. Several authors have analyzed the relationship between interregional transfers and regional inequality in case studies for single countries, whereas the Canadian provinces have been one focal point. Coulombe and Day (1999) compare the evolution of regional disparities in Canada to those of the 12 U.S. states along the Canadian southern border. Although this reference group has extensive similarities in terms of history, geography, institutions, economic structure, and the development stage, regional disparities – measured by the coefficient of variation – have turned out to be 50% higher in Canada compared to the U.S. regions. The reason for this is the systematically lower participation rate and higher unemployment

rate in Canadian provinces, leading the authors to the conclusion that '[government policies are] the most likely factor responsible for the apparent differences, [in particular] the unemployment insurance system, in which benefits are tied to regional unemployment rates, and the intergovernmental transfer payments, which allow poorer provinces to offer a more attractive package of taxes and expenditures than would otherwise be the case' [Coulombe and Day (1999), p. 170-171]. This result is supported by the findings of Kaufman et al. (2003) who also analyze the impact of interregional transfers and the employment insurance on convergence of Canadian provinces. In different panel estimations, they find a weak positive effect of equalization transfers on regional GDP growth per capita, while transfers from the employment insurance always have a negative and highly significant impact on output convergence. The most recent study on convergence determinants of Canadian provinces provides Rodriguez (2006). On the basis of a time-series analysis he concludes '[...] that the interprovincial transfers were not determinant or decisive to the attainment of deterministic convergence in the Canadian provinces'[Rodriguez (2006), p. 26].

From a more international perspective there is a literature evaluating the effects of the European structural policy on growth and convergence of member states. In contrast to our analysis, these studies focus on transfers from supra-national institutions – not national equalization programs – on regional growth. Boldrin and Canova (2001) find no strong divergence or convergence in the EU leading the authors to a double headed conclusion: '*if*, on the one hand, the objective of the EU regional policies is to maximize aggregate economic growth [...], *then* [...] current policies are not appropriate and should be reversed, that is subsidies should be directed to foster agglomeration and divergence. On the other hand, *if* the true objective of regional economic policies is to foster economic growth in the poorer regions and promote convergence, *then* the policies adopted by the Community are not justifiable in the light of current economic knowledge and hard statistical evidence '[Boldrin and Canova (2001), p. 242]. This results are contrasted by Cappelen et al. (2003) who estimate a Solow-type model with panel data and regional support as additional explaining variable. They find a significant positive impact of EU transfers on regional growth and conclude that 'EU regional support through structural funds [...] contributes to greater equality [...]'[Cappelen et al. (2003), p. 640]. To show that the results of this empirical question are still ambiguous Dall'erba and Gallo (2007) find no significant impact of EU transfers on growth and convergence applying a spatial econometrics model. A similar result turns out of the study by Ederveen et al. (2006) who analyze the effects of structural funds on regional growth considering institutional patterns. They find an overall negative impact of transfers on regional growth but a positive

effect for interaction terms of funds and political quality measures. All in all, the different empirical results indicate that the impact of transfers on disparities is not robust in the context of the EU cohesion policy.

Other studies on the relationship of equalization transfers on regional disparities are less comparable. Sala-i-Martin (1996), e.g., analyzes regional growth and convergence of a wide range of countries. Concerning the dispersion of personal income in the U.S. states, he concludes that '[..] it seems as if transfers help reduce cross-state dispersion of per capita income. However, interstate transfers are not responsible for the long run decline in income dispersion'[Sala-i-Martin (1996), p. 1335].

5 Conclusions and outlook

In this paper, we have analyzed the relationship between interregional redistribution and regional disparity both theoretically as well as empirically. For this purpose, we have constructed a theoretical model showing that equalization payments inhibit migration from poor to rich regions, and, thus, hamper the convergence process. We have subsequently tested our model empirically. The evidence suggests a positive relationship between interregional transfers and regional disparities, as measured by the coefficient of variation as well as the adjusted Gini coefficient of regional GDP, both across countries and over time from 1982 to 2000. In the cross-section data, we find that countries with higher levels of interregional redistribution in the past show a subsequent increase in interregional disparity, while countries with lower levels of grants and transfers show less divergence or even convergence. The panel reveals a similar picture: countries who have increased their sub-governmental transfers and grants have experienced more divergence (less convergence) over time than countries who have lowered their transfers. This association is robust for a wide range of potential sources of omitted variable bias as well as endogeneity bias.

The policy implication we derive from our study is that grants are not an appropriate instrument to achieve equal living standards among federation members at all. In light of this, all federations – single nations as well as supra-national institutions as the European Union – should carefully asses their redistributive instruments in how far they really contribute to the convergence of regions.

Although data availability – especially concerning the required regional data – limits the conclusiveness of our results, the evidence in the paper raises a number of interesting issues for further investigation, including whether particular types of in-

terregional transfers are more debilitating for the convergence process, and whether it is possible to incorporate migration in the empirical analysis. Data availability will be the bottleneck for future studies.

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A Appendix

Calculation of measures for regional disparity:

Equation for the coefficient of variation COV:

$$\text{COV} := \frac{\sqrt{\frac{1}{N}\sum_{i=1}^{N}\left(\frac{GDP_i}{pop_i} - \frac{\sum_{i=1}^{N}\frac{GDP_i}{pop_i}}{N}\right)^2}}{\frac{\sum_{i=1}^{N}\frac{GDP_i}{pop_i}}{N}}, \quad 0 \leq cov \leq 1, \tag{A.1}$$

where pop_i denotes the population in region i $(i = 1, ..., N)$, and GDP_i is the gross domestic product.

The commonly used adjusted Gini coefficient ADGINI has similar properties as the coefficient of variation:

$$\text{ADGINI} := \frac{2\sum_{i=1}^{N} i\frac{GDP_i}{pop_i}}{N\sum_{i=1}^{N}\frac{GDP_i}{pop_i}} - \frac{N}{N-1}, \quad 0 \leq adgini \leq 1. \tag{A.2}$$

The last term on the right side of the equation adjusts the 'common' Gini coefficient for the number of regions within a country.

B Appendix

Calculation of transfer measure TRANS2:

The OECD (1999) has developed an internationally comparable framework to assess the degree of control sub-central governments have over their revenues. Table A1 presents the OECD tax classification framework.

Table A1
OECD framework of tax classification

Classification of taxes in decreasing order of control over revenue sources		
(a)		SCG determines tax rate and tax base.
(b)		SCG determines tax rate only
(c)		SCG determines tax base only
(d)		tax sharing:
	(d.1)	SCG determines revenue-split
	(d.2)	revenue-split only changed with consent of SCG
	(d.3)	revenue-split unilaterally changed by central government (CG)
	(d.4)	revenue-split unilaterally changed by CG (in annual budgetary process)
(e)		CG determines tax rate and tax base

CG: central government; SCG: sub-central government; Source: OECD (1999).

While the first three rows (a, b, and c) in Table A1 could be interpreted as taxes over which sub-national governments can decide autonomically, (d.1) and (d.2) represent shared (or composite) taxes which are influenced by both central and sub-central governments. In the cases (d.3), (d.4), and (e) the taxes are completely controlled by the central government. All kinds of taxes covered by the OECD Government Revenue Statistics are classified in this respect.

Using this classification we can separate sub-national autonomous (a, b, and c) and non-autonomous (d.1, d.2, d.3, d.4, and e) revenues. The TRANS2 measure is then calculated as:

$$\text{TRANS2} = \frac{\text{total sub-national revenues} - [(\text{a+b+c}) + \text{non-tax} + \text{capital revenues}]}{\text{total government revenues}}. \tag{B.1}$$

C Appendix

Table A1
Variable definitions and sources

Variable	Definition	Source
COV	Coefficient of variation of regional GDP per capita (NUTS2 level in member countries of the European Union, state level otherwise)	National statistics, own calculations
ADGINI	Adjusted Gini coefficient of regional GDP per capita (NUTS2 level in member countries of the European Union, state level otherwise)	National statistics, own calculations
TRANS1	Grants received by national and sub-national governments from other levels of government (without grants from abroad or supra-national institutions) as share of total government revenues	IMF Government Finance Statistics
TRANS2	Sub-national non autonomous revenues as share of total government revenues adjusted for sub-national transfers to other government levels	OECD Revenue Statistics
GDPPC	Gross domestic product per capita	World Bank (WDI)
UNEMPL	Unemployment rate	World Bank (WDI)
POP	Total population	World Bank (WDI)
POPGINI	Gini coefficient of regional population size	National statistics, own calculations
URBAN	Share of urban living population	World Bank (WDI)
SOCIAL	Total government social expenditures as share of GDP	World Bank (WDI)
DEC	Sub-national expenditures as share of total government expenditures	IMF Government Finance Statistics

Table A2
Robustness check: panel estimations

	Dependent variable: ADGINI			
	OLS	OLS	TSLS	TSLS
	(1)	(2)	(3)	(4)
TRANS1	.127**		.135	
	(2.64)		(.61)	
TRANS2		.101**		.072
		(2.65)		(1.39)
GDPPC	.007***	.007***	.008***	.008***
	(4.13)	(3.94)	(4.35)	(4.24)
UNEMPL	.203***	.223***	.185*	.186
	(3.49)	(3.55)	(1.69)	(1.64)
POP	-.280***	-.252***	-.281***	-.362***
	(-7.83)	(-7.93)	(-3.18)	(-7.67)
POPGINI	.951***	.974**	.890	1.096*
	(3.07)	(2.60)	(.95)	(1.77)
URBAN	-.117*	-.076	-.128*	-.073
	(-1.88)	(-1.26)	(-1.86)	(-1.22)
SOCIAL	-.001	-.001	-.001	-.001*
	(-1.30)	(-1.52)	(-1.07)	(-1.87)
DEC	-.223***	-.225***	-.163*	-.130**
	(-3.62)	(-4.32)	(-1.71)	(2.21)
Country Dummies	Yes	Yes	Yes	Yes
Time Dummies	Yes	Yes	Yes	Yes
Obs	17 (92)	17 (92)	17 (77)	17 (74)
Adj.-R^2	.93	.93	.94	.95
F-Test (p-value)	.000	.000	.000	.000
Sargan-Hansen statistic	–	–	.000	.000

Note: t-values in parenthesis; ***, **, and * indicate significance at 1%, 5%, and 10%, respectively.