Interregional Redistribution and Mobility in Federations: A Positive Approach*

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Abstract The paper studies the effects and the determinants of interregional redistribution in a model of residential and political choice. We find that paradoxical consequences of inter-jurisdictional transfers arise if people are mobile: while self-sufficient regions are necessarily identical with respect to policies and average incomes in our model, interregional redistribution always leads to the divergence of regional policies and per capita incomes. Thus, interregional redistribution prevents inter*regional* equality. At the same time, however, transfers may allow for more inter*personal* equality among the inhabitants of each region. The voting population may therefore in a decision over the fiscal constitution deliberately implement such a transfer scheme to foster regional divergence. Empirical evidence from panel data from OECD countries and Candian provinces is consistent with the theory.

Keywords: Interregional Transfers, Fiscal Federalism, Regional Inequality
JEL-Classification: H71, H73

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1 Introduction

Most countries are organized as federations. They are formed of a system of jurisdictions across which economic activity is unrestricted and which enjoy some degree of political independence from the federal government. The main argument that justifies this organizational form is the following: on the one hand, economic integration guarantees free trade and factor mobility to exploit the efficiency gains from common markets. On the other hand, decentralized decision making ensures that local policies are customized to the needs of potentially heterogeneous populations with different regional tastes. Apparently, this institutional arrangement is so attractive as to foster the integration of nations into federations with the European Union as a prominent example. Yet, the local political autonomy present in many federal states need not be accompanied by the corresponding financial autonomy: the linkage between local revenues and expenditures is frequently broken through inter-jurisdictional redistribution. In Canada, Italy, Germany, and the EU, for example, this redistribution takes the form of unconditional interregional 'equalization grants' that are part of an explicit program designed to diminish regional inequalities. Alternatively, the interregional redistribution may be carried out in a more indirect way as in the U.S., where the federal government redistributes public revenues across states through the use of federal grants.

The numbers involved are significant.[1] Germany's interstate transfer system *Länderfinanzausgleich*, for instance, is founded on the constitutional goal to 'equalize living standards' across the nation (Article 72) and is itself explicitly accounted for in the constitution (Articles 106 and 107). A total of 16.9 billion Euro, or 8.8 % of local revenues, was directly transferred between the German states, not counting federal 'special cohesive transfers', which mostly flowed to states in the East. In Canada, the formal *Equalization Program* was established as a federal responsibility in Section 36(2) of the Constitution Act 1982 with the objective of 'ensuring that provincial governments have sufficient revenues to provide reasonably comparable levels of public services as reasonably comparable levels of taxation'. In 2000-2001, the Canadian federal government paid a total of CND $ 10.8 billion to eight of the ten provinces, which amounts to up to 25 percent of the public revenues in the Atlantic provinces and close to 10 percent in Quebec. Even the European Union with its relatively small financial links redistributes a sizable portion of its expenditures among member states through its *Struc-*

[1] Not least for this reason, the interregional transfer scheme has recently been subject to a heated political debate in several countries such as Germany, Italy, and Canada.

tural Funds, which are directed at 'reducing disparities and promoting economic and social cohesion in the European Union' (Articles 130A and 130C of the Single European Act and Article 10 (3) of Council Regulation (EC) N 1260/99). The EU spend 28.7 billion Euro, or roughly 30% of its entire budget, on this transfer scheme in 2002. Yet, regional disparities are a persistent phenomenon. Indeed, a recent look at the most developed OECD countries reveals that divergence rather than convergence is the norm. During the 1990's, for instance, the coefficient of variation of regional GDP grew by 16 percent on average, and 14 out of 23 countries experienced increasing inter-regional inequality.[2]

This paper aims to provide a new perspective on interregional redistribution as well as an explanation for why it may not be an appropriate instrument to reduce interregional disparities. We start from the observation that regional differences in living standards and policies will give rise to migration if households are mobile. In a world of falling mobility cost and increasing economic integration, migration – as a substitute or a complement to interregional redistribution – should thus be taken into account when studying the determinants and the consequences of horizontal transfers in a federation of jurisdictions.

To this end, we develop a model which we believe will reflect the stylized characteristics of federal systems reasonably well. We consider an economy divided into two jurisdictions that form a federation. Since the jurisdictions are part of a federal entity, regions cannot impose (explicit or implicit) constraints on the movement of citizens across their borders, i.e., there is free migration and equal treatment of immigrants everywhere. Each region controls a fiscal policy which is determined by majority vote of its residents. Because we take the population to be heterogeneous, political decisions are not taken unanimously and there is a conflict of interest among local voters that manifests itself in inefficiently high levels of local public spending. Local population structures are not exogenous, however. Rather, agents migrate in response to policy (tax base) difference across regions. At the same time, residential choices determine policies through the democratic process. There is thus an interdependency between residential and political choices of agents, which together with the inefficiencies generated by the political conflict of interest, is at the heart of our analysis.

The existing literature on interregional redistribution, in contrast, sees them as instruments

[2]Data Sources: *Der Länderfinanzausgleich in Zahlen*, Bundesfinanzministerium 2002, The Atlantic Provinces Economic Council's *Atlantic Report*, Vol. 35, No. 4, Winter 2001, the *European Union Financial Report 2002*, European Commission 2003, and the *OECD Territorial Outlook 2001*, OECD.

to either internalize externalities that may arise from spill-over effects or competition between jurisdictions, or to cushion individual income risk and regional specific shocks. These important issues are the subject of contributions by Boadway and Flatters (1982), Myers (1990), Wildasin (1991), Persson and Tabellini (1996a, 1996b) and Besley and Coate (2003) and are by now fairly well understood. The main difference lies in our focus on the political economy aspects of intra- versus interregional redistribution in the presence of mobility. In the section below, we discuss the relationship of the present model with the literature.

In a preliminary step in our analysis, we first consider a situation without transfers, i.e., where jurisdictions are financially self sufficient. In this case, we find that free and costless migration suffices to bring about regional convergence in terms of policies and per capita incomes. Moreover, the identical policies selected at the local level are equal to the policy that would have been chosen in a central regime, i.e., through majority vote of the entire population. This outcome of convergence as a result of migration is a property of our model that reflects the well-known phenomenon of the 'poor chasing the rich' and serves as a starting point of our analysis. In a second step, we then introduce inter-jurisdictional transfers that are financed out of, or flow into, local budgets. Allowing for interregional redistribution between regions changes the picture dramatically. Regions now 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. Intuitively, transfers prevent the migration from poor regions into wealthy regions that helps to equalize local living conditions if households are sufficiently mobile. Thus, the paradoxical situation arises that interregional transfer payments *sustain interregional (income-)inequalities that could not persist otherwise*. While this situation could be perceived as inequitable, our last set of results also shows that interregional redistribution can be beneficial for other reasons. Specifically, the transfer-sustained equilibrium sorting of the population according to income may decrease the heterogeneity of the population structure in each jurisdiction. We also present some empirical evidence that is consistent with both of these implications of our theoretical model. First, using panel data from 17 OECD countries, we show that a higher level of inter-regional transfer payments is positively associated with (future) differences in income inequality across regions, i.e., countries who have increased their sub-governmental transfers and grants subsequently experienced more divergence (less convergence) *across* regions over time than countries who have lowered their transfers. Second, panel data from Canadian provinces reveal that transfers are negatively associated with differences in income inequality within the regions of a single federation, i.e., more inter-regional redistribution within Canada went hand in hand with less income inequality *within* the provinces.

Since inter-regional transfers have a negative effect on inter-personal inequality, they endogenously lower the distortions introduced by the conflict of interest inherent in the democratic process through which local policies are determined. Expressed differently, the induced greater homogeneity of local preferences in equilibrium facilitates a better tailoring of public activities to local circumstances and, hence, a 'government closer to the people'. As a consequence, the individual losses arising from the local collective choice process are lower than in a federal system without interregional redistribution and a central regime, respectively. For this reason, it may be optimal to select decentralization accompanied by a scheme of interregional financial aid at a constitutional stage where the entire population votes over its governance structure. On the normative side, our findings thus imply that interregional transfers can be welfare enhancing because they may promote inter*personal* equality among the population in each region. This is true precisely because they at the same time allow for more inter*regional* inequality across the entire federal system.[3] Empirical evidence from Canadian provinces and OECD countries supports the main implications of our theoretical model.

Relation to the Literature

The present model is related to several lines of research. First, there is a number of contributions on the effects of interregional redistribution. Largely ignoring the obvious and often stated equity objective of fiscal equalization programs, this work has focused mostly on their efficiency properties. One strand of research has noted the similarity to Pigouvian taxes and subsidies, and pointed to the potential to correct for various externalities among jurisdictions. Boadway and Flatters (1982), Myers (1990), Wildasin (1991), and Hindriks and Myles (2003), for example, show in various contexts that interregional transfer mechanisms can help to internalize migration induced (fiscal) externalities and achieve an efficient allocation

[3] Our findings thus support the view that the accommodation of diverse local preferences provides a strong rationale for a decentralized organization of the state, provided a central government does not (or cannot) discriminate among regions [see, e.g., Oates (1972)]. Yet, they also indicate that mobility plays a crucial role in this regard. If households are mobile and preferences are related to income, persisting differences across regions under decentralization may be sustainable only through interregional transfers.

of individuals across regions. While interregional payments also serve the role of affecting migration in these models, their rationale is based on efficiency and (overall) welfare maximization grounds, rather than on the redistributive and political economy motives present in our framework. Moreover, transfers in these models still tend to eliminate – rather than sustain or create – interregional differences [see, e.g., Boadway and Flatters, pp. 629-360]. A different perspective on inter-governmental grants is taken by Lülfesmann (2002), Besley and Coate (2003) and Kessler et al (2006), who consider settings where such transfers are necessary compensation payments in Coasian (efficient) bargaining between regions over the provision of a local public good with spill-over effects. Finally, Persson and Tabellini (1996a, 1996b) explicitly analyze the political economy aspects of intra- versus interregional redistribution like we do. In contrast to our model, they do not allow for migration and instead emphasize the role of interregional transfers in sharing regional specific risks.

Second, the effects of mobility on local policies and the incentives for countries to fiscally (de-)centralize have been investigated by Bolton and Roland (1997). The authors analyze a political-economy model with redistributive (local) policies, heterogeneous agents, and tax competition for mobile physical and human capital. For a given local population structure, there may be political support in favor of fiscal decentralization in order to set the policy preferred by the local median voter. Once the population is mobile, migration eliminates all cross-country differences. Although derived in a somewhat different context, this result mirrors our symmetric equilibrium in the absence of transfers. But since Bolton and Roland do not consider interregional transfers, all migration does is to bring about convergence. As a consequence, the advantages of fiscal decentralization vanish.

Third, the present model draws on the multi-community models in the Tiebout tradition such as Westhoff (1977), Epple and Romer (1991), Fernandez and Rogerson (1996), Nechyba (1997), Glomm and Lagunoff (1998), and Hansen and Kessler (2001a,2001b) who study equilibrium characteristics when residential and political choices are intertwined. Our analysis contributes to this literature because we are able to formally relate the existence and the characteristics of equilibria to the policy under consideration, whereas most papers rely on simulations to evaluate the implications of different policy measures. An exception is Fernandez and Rogerson (1996) who can characterize those analytically, which we discuss in more detail below.

The remainder of the paper is organized as follows. The basic model is presented in Section 2, which proves existence and analyze characteristics of equilibria for a given fiscal constitution (interregional transfer scheme). Constitutional choice is considered in Section 3. Section 4 presents some empirical evidence in support of the theory. Section 5 concludes. All proofs are relegated to the Appendix.

2 The Model

Consider an economy populated by a continuum of individuals with measure normalized to unity. Individuals have identical preferences over the consumption of a composite commodity c and a publicly provided good g that benefits the residents of the providing jurisdiction only. For analytical convenience, we assume preferences to be quasi-linear,

$$u(c, g) = c + U(g), \quad U' > 0, U'' < 0,$$

where U is twice differentiable and satisfies the Inada condition $\lim_{g \to 0} U'(g) = \infty$. Individuals are heterogeneous with respect to their endowed income y which is distributed across the population according to the distribution function $F(y)$ with continuous density $f(y) > 0$ on $[\underline{y}, \bar{y}] \subset \mathbb{R}^+$. In line with empirical evidence, we assume that $f(\cdot)$ is unimodal and skewed to the right, i.e., the median income y_c^m in the overall population is smaller than average income $\overline{Y}_c$.[4]

Institutionally, the economy is divided into two jurisdictions indexed by $j = 1, 2$, which may be communities, regions, or member countries of a federation.[5] All citizens can move freely and costlessly between jurisdictions but live in only one. The local public good provision $g_j \in \mathbb{R}_0^+$ is financed by a proportional income tax $t_j \in \mathbb{R}$ levied according to the residence principle. The indirect utility function of an individual with gross income y that lives in jurisdiction j is thus

$$V(t_j, g_j, y) = (1 - t_j)y + U(g_j). \tag{1}$$

[4]While the assumption on the skewedness of $f(y)$ is rather weak, unimodality is more disputable. There are examples of income distributions which are bimodal, e.g., the distribution of household incomes in Great Britain. Most nationwide income distributions, however, appear to be unimodal independent of the measurement concept [see e.g. Burkhauser et. al. (1997)]. Unimodality is also satisfied by the Lognormal and the Pareto distributions that are often used to approximate real world income distributions.

[5]The model can easily be extended to more than two jurisdictions. See the discussion at the end of Section 2.2.

Political decisions are democratic and decentralized, i.e., local policies (t_j, g_j) are chosen independently in each region by majority rule. However, 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 at a constitutional stage that is made precise in Section 3 below. Throughout Section 2, we take T_j as exogenously given and only require $T_1 + T_2 = 0$ so that the overall federal budget is always balanced. Also note that we treat T_j as a lump sum transfer, which helps to simplify the formal analysis. It will become clear below, though, that T_j can alternatively be expressed as a function of the local tax base, which is more in accordance with existing institutions.

To abstract from efficiency effects of population size, 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.[6] Denoting by $f_j(y)$ the measure of agents with income y living in jurisdiction j, let $\alpha_j = \int_{\underline{y}}^{\bar{y}} f_j(y)dy$ be the size of the population and $\overline{Y}_j = \int_{\underline{y}}^{\bar{y}} y f_j(y)dy/\alpha_j$ average income in j. The local budget constraint in per capita terms, which defines the set of feasible policies in region j, then reads

$$g_j = t_j \overline{Y}_j + T_j/\alpha_j, \qquad j = 1, 2. \tag{2}$$

If interregional redistribution takes place $(T_j \neq 0)$ there will be a donor region, financing a total of $-T_j > 0$ through local tax revenues, and a recipient region whose budget is expanded by $T_j > 0$. For $t_j = 1$, region j supplies the highest feasible level of public good provision, $g_j^{\max} = \overline{Y}_j + T_j/\alpha_j$. Conversely, the lowest feasible level of public good supply $g_j = 0$ corresponds to a (possibly negative) tax rate of $t_j = -T_j/(\alpha_j \overline{Y}_j)$.

Given the fiscal constitution that is determined at a constitutional stage 0, the sequence of events is as follows. In stage 1, citizens simultaneously choose a jurisdiction in which to reside. In stage 2, the residents of each region determine local redistributive policies by majority vote, consume their after tax income and the local public service.

Definition. *An equilibrium in the system of jurisdictions for a given transfer sheme T_j is a vector of local policies (t_j^*, g_j^*) and a distribution of households over jurisdictions $f_j^*(y)$, for $j = 1, 2$, that satisfy*

[6] As in most of the literature, g_j is thus a publicly provided private good such as health care or education. Bergstrom and Goodman (1973) and Edwards (1990) report empirical evidence that most goods provided by local governments are private in nature.

a) given residential choices, the local policy in each jurisdiction is feasible and preferred to any other feasible policy by a majority of the jurisdiction's inhabitants;

b) each household chooses its residence optimally, perfectly anticipating political developments at the subsequent stage.

That policies are determined *after* residential choices have been made allows us to disregard tax competition effects between jurisdictions and concentrate instead on the interaction of demographic and political conditions in a federal system.[7]

We solve the model backwards. In stage 2, the fiscal policy implemented in jurisdiction j must be supported by a majority of the jurisdiction's inhabitants, given the local population. The preferred policy of a voter with income y maximizes her utility (1) subject to the budget constraint (2) of the community.[8] Along an indifference curve of a y-type voter, we have

$$\frac{dg}{dt}\Big|_{V=\overline{V}} = \frac{y}{U'(g)}, \tag{3}$$

so that preferences are single peaked and vary monotonically with income. Applying the median voter theorem, the unique majority rule outcome is the feasible policy that is most preferred by the individual with median income. Denoting this income by y_j^m, and recalling that $g_j^{\max}$ constitutes an upper bound on g_j, the equilibrium policy (t_j^*, g_j^*) in region j is determined by

$$t_j^* = \frac{g_j^* - T_j/\alpha_j}{\overline{Y}_j}, \quad U'(g_j^*) = \frac{y_j^m}{\overline{Y}_j} \tag{4}$$

for $U'(g_j^{\max}) \leq y_j^m/\overline{Y}_j$ and $(t_j^*, g_j^*) = (1, g_j^{\max})$ otherwise. Hence, the equilibrium level of local public good provision solely depends on the local ratio of median to mean income, which we denote by $\sigma_j = y_j^m/\overline{Y}_j$ for brevity of exposition. Specifically, g_j^* is non-increasing in σ_j: the higher the local ratio of median to mean income, the lower chosen public good supply and vice versa. Intuitively, this monotonicity property stems from the fact that the public good

[7]See also, e.g., Fernandez and Rogerson (1996, 1997) and Hansen and Kessler (2001a, 2001b). This sequential model is equivalent to the assumption that households migrate, vote and consume simultaneously but do not foresee migration responses to their political choices, as in, e.g., Westhoff (1977) and Nechyba (1997). A notable exception is Epple and Romer (1991) who consider a multi-community model in which voters anticipate policy-induced migration.

[8]To rule out the indeterminacy of voting equilibria when there are infinitely many agents (of which no single one is decisive) we assume sincere voting. Also note that neither jurisdiction can be empty as with more income classes than jurisdictions, there are always agents that would prefer to relocate in an empty community where they can impose their preferred policy.

is a substitute for private consumption and that the taxes levied on income are redistributive in nature.

For future reference, observe that the redistributive aspects of raising public funds through proportional taxation together with the political process results in an inefficiently high (low) provision of the public good as σ_j falls short of (exceeds) unity: since per capita cost of providing a unit of the public good are constant and equal to one, efficient provision g^e is characterized by

$$U'(g^e) = 1.$$

Next, we describe residential choices. The preferences of agents over policies and, hence, jurisdictions are depicted graphically in Figure 1, which displays the indifference curves $\overline{V}$ of three individuals with incomes $y' > \tilde{y} > y''$. From (3), a wealthy individual's indifference curve in each point of the policy space is steeper than a poor individual's.[9] As is common in this type of model, any equilibrium in which jurisdictions offer distinct policy bundles then has the following characteristics: first, one region must offer lower taxes and public good provision than the other region (otherwise, no individual would want to reside in the region with both higher taxes and lower public spending). Second, we see from (3) that individuals with high incomes (as y') *ceteris paribus* prefer low tax rates and lower public spending. Consequently, they settle in the region with lower government activity, which we without loss of generality take to be region 1 in what follows. Conversely, poorer individuals (such as y'') prefer high taxes and a more generous public spending and, hence, settle in region 2. Thus, the equilibrium will be characterized by sorting according to incomes or *stratification*. Finally, since both jurisdictions must populated, there will be a 'boundary' household $\tilde{y}$ which is indifferent between the two regions.

[9]This property is due to the fact that the marginal rate of substitution along an indifference curve is decreasing in income as in, e.g., Glomm and Ravikumar (1998) and Epple and Romer (1991), which seems to be the relevant case if public spending is mostly redistributive in nature; for instance, it naturally arises in the special case of purely redistributive policies with distortive taxation (see an earlier version of this paper). Alternatively, one could assume that the MRS increases in income as in, e.g., in Fernandez and Rogerson (1996, 1997), which is more relevant for public expenditures such as education. We wish to emphasize that this alternative assumption would not change our results qualitatively. See page 9 below and Section 5 for a discussion on this point. In particular, we could allow for both possibilities along the lines of Glomm and Lagunoff (1998) and Epple and Romano (1996).

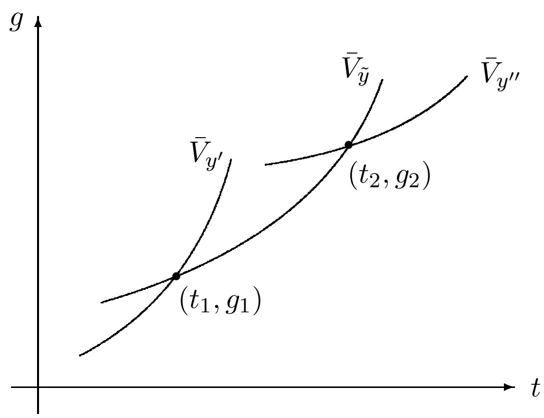

Figure 1

2.1 Equilibrium under Financial Independence

While the above-described situation with asymmetric regional policies and sorting of households according to income classes is suggestive, the following result establishes that no such equilibrium can exist if regions are financially self sufficient:

Proposition 1. *Without interregional transfers, only symmetric equilibria with the following properties exist:*

a) $\overline{Y}_1^* = \overline{Y}_2^* = \overline{Y}_c$ *and* $y_1^{m*} = y_2^{m*} = y_c^m$,

b) $(t_1^*, g_1^*) = (t_2^*, g_2^*) = (t_c^*, g_c^*)$,

where (t_c^*, g_c^*) *is the policy that would be chosen by majority vote of the entire population in a centralized system (consisting of only one jurisdiction).*

The existence of a symmetric equilibrium is a common to most multi-community models and as it is straightforward to show, we have omitted a formal proof. It is also easy to see the policy equivalence with the centralized system: for $T_j = 0$ and $(t_1^*, g_1^*) = (t_2^*, g_2^*) > 0$, $\overline{Y}_1^* = \overline{Y}_2^* = \overline{Y}_c$ follows directly from the local budget constraint (2). Assuming that the most preferred level of public good provision of the decisive federal median y_c^m is feasible given the federal tax base, g_c^* satisfies (4) for $\sigma_c = y_c^m / \overline{Y}_c$ and we must have $y_1^{m*} = y_2^{m*}$[10] which together with $\sum_j f_j^*(y) = f(y)$ implies $y_j^{m*} = y_c^m$.

[10]Observe that $y_1^{m*} \neq y_2^{m*}$ is consistent with $(t_1^*, g_1^*) = (t_2^*, g_2^*) > 0$ only if $t_j^* = 1$ and $g_j^* = g_j^{\max} = \overline{Y}_c$ which contradicts the assumption that $g_c^* < g_c^{\max} = \overline{Y}_c$ (as it is impossible to have $\sigma_j^* < \sigma_c$ in both regions).

The more surprising part of Proposition 1 is that there can be no other (sorting) equilibria if regions are financially self-sufficient.[11] To understand this result intuitively, suppose we had a situation as in Figure 1 with asymmetric local policies and stratification. Now, if the boundary individual $\tilde{y}$ resides in the poor jurisdiction, she has the highest income there and, hence, is a 'net contributor' to the local budget in terms of the private consumption good. If she moved to the wealthy jurisdiction 1, in contrast, she would be the lowest income individual there and be 'net recipient' of local public funds. In the case of pure redistribution, g is a pure monetary transfer and it follows immediately that the individual would strictly prefer to live in the wealthy region [see also Bolton and Roland (1997)]. In our more general setup, the negative utility difference cannot be compensated by the higher public good supply in jurisdiction 2 as long as marginal utility of private consumption exceeds marginal utility of public consumption, i.e., as long as both jurisdictions offer an inefficiently high level of g. As we demonstrate in the appendix, local oversupply of public goods must be a feature of any equilibrium under our assumptions on the overall income distribution (skewed to the right and unimodal). Because there is already too much public spending in both regions, those individuals with the highest incomes in the poor region always benefit from moving to the wealthy region where public spending is lower and they are at the receiving end of the population, a contradiction to the definition of an equilibrium. This line of argument illustrates a variant of the problem of 'the poor chasing the rich', which arises in our context and serves as a starting point of the analysis that follows.

One should also note that this non-sorting result does not depend on our exact preference specification and the implied properties of any potential stratification equilibrium. In particular, it also holds if high-income individuals prefer higher taxes and more public spending than the poor, as long as induced preferences continue to depend on the ratio of median to mean income. In such a situation, the private consumption good and the local public good are complements rather than substitutes, and a necessary condition for sorting equilibria is that poor regions spend less on local public goods than wealthy regions. Because the local median to mean ratios are always always less than one in a sorting equilibrium, local public goods are undersupplied in both jurisdictions. But then high income individuals in poor regions will have an incentive to move because the utility-gain from the higher level of public goods in the wealth region cannot be compensated for by the lower taxes in the poor region

[11] See Lemma 1 and its proof in Appendix A.

since the marginal utility of private consumption falls short of the marginal utility of public consumption.[12]

To summarize, the unique equilibrium outcome under financial autonomy not only involves identical policies of the independent jurisdictions, but it is also characterized by harmonization of economic and demographic variables such as average incomes and parameters of the local population distributions. This equalization is driven by migration only and does not follow from inter-jurisdictional transfers or other policies directed to equate the standards of living among federation members. Moreover, the federal structure of the economy is of no consequence if jurisdictions are not linked financially: the policy carried out in each jurisdiction is identical to that chosen under a centralized system, provided the central (federal) policy is uniform across regions and chosen by majority vote of the overall population.

2.2 Equilibria with Interregional Transfer Payments

We can now turn to horizontal payments between regions and how they alter equilibrium characteristics. While we treat these transfers as intergovernmental in what follows, one could equally imagine a central institution such as the federal government imposing a transfer scheme to pursue interregional redistribution. As a preliminary step in our search for an equilibrium, recall that any asymmetric equilibrium must be characterized by stratification and $(t_1, g_1) < (t_2, g_2)$. But for such policies to form a majority rule outcome, the median to mean income ratios in both regions cannot take arbitrary values. Suppose for instance $T_j = 0$ and consider a partition with a boundary income $\tilde{y}$. Then, a necessary condition for an equilibrium is that the median to mean income ratio among the wealthiest $1 - F(\tilde{y})$ agents (residing in region 1) exceeds the corresponding ratio among the $F(\tilde{y})$ poorest agents (residing in region 2). As we show in the Appendix, there are partitions of the population where this is the case, i.e., the set $\mathcal{Y} = \left\{\tilde{y} \in [\underline{y}, \overline{y}] | \sigma_1(\tilde{y}) > \sigma_2(\tilde{y})\right\}$ is non-empty. For all values $\tilde{y} \in \mathcal{Y}$, therefore, the political preferences of the local residents imply higher levels of public spending among the poor living in region 2 than among the wealthy living in region 1. We are now in the position to state our first major result.

Proposition 2. *With interregional transfers, only asymmetric equilibria exist. In particular,*

[12] See also Hansen and Kessler (2001b) for a more general analysis of the non-existence problem in multi-jurisdiction models.

for any $\tilde{y} \in \mathcal{Y}$, there is a transfer scheme from region 1 to region 2, $T_2(\tilde{y}) = -T_1(\tilde{y}) > 0$, that supports an equilibrium with the following properties:

a) all individuals with incomes $y > \tilde{y}$ live in region 1,
all individuals with incomes $y < \tilde{y}$ live in region 2,

b) $(t_1^*, g_1^*) < (t_2^*, g_2^*)$,

c) $V(t_1^*, g_1^*, \tilde{y}) = V(t_2^*, g_2^*, \tilde{y})$.

Proof. See Appendix A.

The proposition states that horizontal redistributive transfers support the divergence of jurisdictions both economically and politically: high-income individuals cluster in one community, and low-income individuals cluster in the other. As a consequence, regional per capita incomes diverge, $\overline{Y}_1 > \overline{Y}_2$. Local policies are different as well and are characterized by more government activity in the poor as compared to the wealthy region (despite the fact that the transfer is financed out of the latter region's tax revenues). These properties stand in sharp contrast to the situation without interregional grants, where policies and average income across jurisdictions were equalized in equilibrium. The reason is simple enough: transfer payments prevent 'the poor chasing the rich' which was the reason for regional convergence under financial independence. Given an artificially augmented budget in the poor region 2, the wealthiest individual in that region, $\tilde{y}$, has no incentive to migrate to the high-income region 1 anymore. While this individual is still a 'net contributor' to local public spending where she lives, she is now compensated by a per capita transfer of $T_2/\alpha_2 > 0$ through inter-regional redistribution At the same time, region 1 becomes less attractive since its taxes have to upwardly adjusted to finance the per capita transfer of $T_1/\alpha_1 < 0$ to the poor community. Both mechanisms suffice to make the boundary individual indifferent between the jurisdictions, a situation which would be impossible in the absence of interjurisdictional transfers. Thus, the paradoxical situation arises that in the presence of migration, *interregional redistribution creates regional inequalities that could not persist otherwise.*

Importantly, the region that receives a positive transfer is *endogenously* inhabited by poorer households while the region that pays the transfer is inhabited by wealthy households in equilibrium. Thus, $T_j(\tilde{y}) > 0$ if and only if $\overline{Y}_j^* < \overline{Y}_c$ and we can always express the scheme $T_2(\tilde{y}) = -T_1(\tilde{y}) > 0$ in a way that is more in accordance with existing mechanisms of interregional redistribution. Specifically, a rule that makes inter-regional payments contingent on average income (tax base) differences generates identical equilibrium outcomes:[13]

Corollary 1. *For any scheme $T_j(\tilde{y})$, $j = 1, 2$ that supports an equilibrium characterized by properties a), b), and c), there exists a parameter $\beta(\tilde{y}) \in (0, 1)$ such that*

$$T_j/\alpha_j^* = \beta\left(\overline{Y}_c - \overline{Y}_j^*\right) = \beta\alpha_k^*\left(\overline{Y}_k^* - \overline{Y}_j^*\right), \qquad j \neq k,\ j, k \in \{1, 2\}.$$

For expositional reasons, we will in the remainder of the paper continue to express the horizontal transfer scheme in terms of $T_j(\tilde{y})$, keeping in mind the isomorphic formulation in terms of $\beta(\tilde{y})$.

Three remarks are in order. First, the above results readily generalize to situations with an arbitrary finite number of jurisdictions $j = 1, .., J$. Proposition 1 clearly continues to hold, i.e., any equilibrium in this economy without inter-jurisdictional redistribution must be symmetric and will be characterized by the equalization of policies and mean incomes. With regard to Proposition 2, let $\{(\hat{t}_k, \hat{g}_k),\ \hat{f}_k(y)\}$ be an asymmetric (stratification) equilibrium for the two region case $k = 1, 2$, supported by a transfer scheme $\hat{T}_k(\tilde{y}) \neq 0$. It is easy to see that there exists a corresponding equilibrium in the economy with any number $J \geq 2$ of regions: partition of the set of jurisdiction into two subsets J_1 and J_2 and set $f_j^*(y) = \alpha_j \hat{f}_k(y)/\hat{\alpha}_k$ for $j \in J_k$ where $\alpha_j \in (0, 1)$ can be chosen arbitrarily with $\sum_{j \in J_k} \alpha_j = \hat{\alpha}_k$, $k = 1, 2$. The population structure in each region is thus a smaller copy of the populations structure of one jurisdiction in the considered equilibrium were $J = 2$. Furthermore, let $T_j = \alpha_j \hat{T}_k/\hat{\alpha}_k$ with $\sum_{j \in J_k} T_j = \hat{T}_k$ be the inter-jurisdictional transfer to be paid or received by jurisdiction $j \in J_k$ and note that per-capita transfers are unchanged relative to the two-region case. The policies resulting from this population structure and per-capita interregional transfer payments are in region $j \in J_k$ given by $(t_j^*, g_j^*) = (\hat{t}_k, \hat{g}_k)$, $k = 1, 2$. The allocation forms an equilibrium and replicates in per-capita terms the allocation in a two region equilibrium as described by Proposition 2, thereby preserving all relevant characteristics.[14]

[13] Recall that the local population structure and, hence, $\overline{Y}_j^*$ is taken as given in the political equilibrium. The majority voting outcome therefore remains unaffected by any such rule.

[14] Increasing the number of jurisdictions may introduce additional (fully stratified) equilibria in which all regions implement distinct tax policies. In equilibrium, jurisdictions can then be ordered in a way such that $j < k$ implies $(t_j^*, g_j^*) < (t_k^*, g_k^*)$. Again, such equilibria could only be sustained by an appropriately chosen inter-jurisdictional transfer scheme. In particular, if there exists a population structure such that equilibrium public good supply $g_j^* \geq 0$ is increasing in j, then $\overline{Y}_j^*$ must be decreasing in j. Along the lines of the proof of Proposition 2, one could then show that a scheme T_j with $T_j > T_k$ for $g_j < g_k$ that supports this equilibrium exists. The results that follow in Section 4 are unaffected by the possibility of those additional equilibria.

Second, it is well known from the previous literature that equilibria in multi-jurisdiction models are frequently unstable with respect to various perturbations; this is particularly true for the symmetric equilibrium [see Fernandez and Rogerson (1996) for details], but can also be a problem with stratification equilibria, as has been shown by Westhoff (1977). We close this section by noting that the stability problem is less severe in the more realistic presence of (small) mobility costs which prevent migration if policy differences are insignificant. For simplicity, we model these costs as moving cost (or a utility loss from leaving a home region) , but it should be clear that congestion effects (as generated, for instance, by housing markets or decreasing returns to scale in public good provision) would serve a similar purpose. As we will see, these modifications do not alter our results qualitatively, and ensure that a small shocks to the local population do not cause further migrational responses. Thus suppose that households incur a fixed small cost of migration $\mu > 0$ whenever they migrate from one region to the other, and note that for small enough μ, both Proposition 1 and Proposition 2 continue to hold, i.e., there will be no asymmetric equilibria without transfers, and no symmetric equilibria with transfers. Next, let us define a stability condition as follows:

Definition. *An equilibrium* $\{(t_j, g_j), f_j(y)\}_{j=1,2}$ *is* locally stable *if there exists an* $\epsilon > 0$ *such that for all* $\{\hat{f}_j(y)\}_{j=1,2}$ *with* $\int_{\underline{y}}^{\bar{y}} f_j(y) - \int_{\underline{y}}^{\bar{y}} \hat{f}_j(y) = \epsilon$ *we have*

$$\forall y, \quad f_j(y) - \hat{f}_j(y) > 0 \quad \Rightarrow \quad V(\hat{t}_k, \hat{g}_k, y) - V(\hat{t}_j, \hat{g}_j, y) < \mu, \qquad j \neq k,\ j,k \in \{1,2\} \tag{5}$$

where $(\hat{t}_j, \hat{g}_j)$ *is the majority-preferred policy in region* j *given the population distribution* $\{\hat{f}_j(y)\}_{j=1,2}$.

This definition adapts the stability condition in Fernandez and Rogerson (1996) to our framework with continuous income distributions. Loosely speaking, an equilibrium is said to be stable if, when a small mass of individuals with arbitrary incomes moves from one jurisdiction to the other, those individuals would strictly prefer to go back to their original (equilibrium) region. It is straightforward to show that either equilibrium as characterized by Propositons 1 and 2 is locally stable in the above sense:

Corollary 2. *Consider a variant of the model in which individuals incur a small cost of migration* μ *when moving from one region to another. In this model with migration cost, the equilibria characterized by Propositon 1 and 2 are locally stable.*

The intuition is simple: as long as the mass of individuals who mistakenly migrate out of their equilibrium region is small, the resulting change in policies will be small as well. This necessarily means that any policy differences remain bounded and converge to zero for $\epsilon \to 0$. But if the utility difference incurred from migrating vanishes, it must necessarily be smaller than the cost incurred by moving, even if those costs are arbitrarily small. Hence, all individuals who locate out of their equilibrium region in the perturbed population structure will strictly prefer to return to their home region.

3 Choosing a Fiscal Constitution

Interregional redistribution between jurisdictions that at the same time control some fiscal variables autonomously is prevalent in many federations. As noted in the Introduction, the primary purpose of these schemes is often to promote interregional equity. In light of the results derived in the previous section, however, it is questionable whether an interregional transfer mechanism is always the appropriate instrument to foster economic convergence. As our model shows, migration alone can suffice to ensure that all equilibria are characterized by similar regional economic (demographic) and political indicators. In contrast, interregional redistribution implicitly prevents migration and therefore – if such convergence was indeed the political objective – would do more harm than good.

In reaching this conclusion, we have disregarded important factors such as housing markets or economies of scale in the public sector that may allow for asymmetric (stratification) equilibria even in the absence of interregional transfers.[15] Furthermore, although direct and indirect mobility cost have been decreasing substantially through technological improvements and liberalization worldwide, migration is in practice neither costless nor perfectly free as it is in our model.[16] In those respects our results can provide only a benchmark. Nevertheless, we

[15]See, e.g., Westhoff (1977), Epple et al. (1984) and Nechyba (1997) for formal arguments on this point. In general, the question of which factors are sufficient for sorting is still open. Hansen and Kessler (2001a), for example, show that housing markets only support stratification when regional land size differences are sufficiently pronounced. See also Rhode and Strumpf (2003), who conduct an empirical analysis and find that, despite falling mobility cost, heterogeneity in policies and preferences across local US jurisdictions (counties and municipalities) has dropped over the period of 1870-1990.

[16]One should bear in mind, though, that the right of free migration is a distinguishing characteristic of federations. It involves both the nondiscrimination of immigrants from other members of the federation and the absence of explicit migration controls and is typically laid down in the general rules constituting a federal system. U.S. citizens, for example, are granted this right in their constitution. In the EU and in Germany, free migration is guaranteed in the Treaties of Rome, and in Article 11 of the *Grundgesetz*, respectively.

believe that our analysis embodies an important lesson that is more general than is a priori suggested: there are circumstances in which migration tends to diminish regional inequalities, and, if this is the case, all interregional transfers can do is to preserve or enhance stratification and prevent equalization, both politically and economically. Taking these implications of our model as given, we can now turn to the question whether there are other objectives (if not convergence) that might be pursued by interregional redistribution in federal systems.

3.1 Efficiency and Interregional Redistribution

First, reconsider a situation where the total population of the system votes over the fiscal policy (centralized government) and recall that, by assumption, the centrally chosen policy satisfies $g_c^* < g_c^{\max}$ so that

$$U'(g_c^*) = \frac{y_c^m}{\overline{Y}_c} = \sigma_c < 1.$$

In other words, the redistributive nature of taxation implies a political conflict of interest, which together with our assumption on the overall distribution of income, $y_c^m < \overline{Y}_c$, implies that g_c^* is chosen inefficiently high.[17] From Proposition 1, we also know that the same inefficiency would occur in equilibrium under a decentralized fiscal system in which the two jurisdictions are politically and financially independent.

Now suppose intergovernmental grants $T_j \neq 0$ are implemented and funds are transferred from the wealthy jurisdiction to the poor jurisdiction in an asymmetric equilibrium. Such an equilibrium is fully characterized by the boundary income $\tilde{y}$ since local median and mean incomes and, thus, local policies, are functions of $\tilde{y}$ only. From Proposition 2, we know that choosing a horizontal transfer scheme then amounts to selecting among different (stratification) equilibria characterized by different partitions $\tilde{y} \in \mathcal{Y}$. As one can show, some of these equilibria are characterized by $1 \geq \sigma_1 \geq \sigma_2 > \sigma_c$, i.e., we can find a partition of the population where the local population structure in both jurisdictions is more *homogeneous* than the overall population structure in the sense that the local mean to median income ratios are larger and closer to one than the corresponding ratio in the federal system. Hence, there will exist (stratification) equilibria characterized by a boundary individual $\tilde{y}$ and supported by a

[17] In line with the traditional view of the literature on fiscal federalism, we assume here that centralized provision of the public good is uniform across jurisdictions, i.e., the central government does not discriminate among regions and provides the same level of g_c everywhere, which is financed by a federal income tax. For recent exceptions, see Besley and Coate (2003) and Lockwood (2002) who study of the choice of centralized versus decentralized provision in models with policy formation through legislative bargaining.

balanced inter-jurisdictional transfer scheme $T_j(\tilde{y})$ such that[18]

$$g^e \leq g_1^* \leq g_2^* < g_c^*.$$

This result is of interest for two reasons. First, lower public good provision under decentralization does not result from tax competition, because by definition of equilibrium, strategic motives for taxation are ruled out. Second, government activity under decentralization is lower although the intergovernmental grant augments the poor jurisdiction's public budget. The explanation for reduced equilibrium public good supply solely lies in the demographic structure of the local populations in the decentralized equilibrium with inter-regional redistribution: it is more *homogeneous* than under centralization and the decentralized equilibrium without interregional aid, respectively. More specifically, local income inequality will be lower, thereby diminishing the political conflict of interest and the resulting motive for internal redistribution, which translates into (locally) oversupplied public goods.

3.2 Voting for a Constitution

We now investigate how the population of an economy decides upon its governance structure at a constitutional stage. The fiscal constitution to be determined could prescribe a centralized system, a federal system with two financially autonomous jurisdictions or a federal system in which the jurisdictions determine their policies independently, but are linked by some kind of interregional transfer mechanism.[19] Since we know from Proposition 1 that centralized and the decentralized political decisions without interstate transfers yield identical equilibrium outcomes, we can restrict our attention to the choice between the centralized structure and the decentralized structure with interregional redistribution. In what follows, we consider two scenarios for the constitutional choice of individuals and examine each of them in turn.

Constitutional Choice Under the Veil of Ignorance

When considering the choice of a constitution, it seems reasonable to require some impartiality in the political mechanism when considering the choice of a constitution. This idea is

[18] See Lemma 2 and the proof of Proposition 2 in Appendix A for details.

[19] As mentioned above, we formally treat this mechanism as an intergovernmental grant. Provided the decision on local policies remains at the local level, one could alternatively - and in fact equivalently - allow a central government to take a more active role in interregional redistribution, both explicitly and implicitly. In the latter case, for instance, the transfers T_j could stem from federal income taxation and targeted regional grants.

captured by the 'veil of ignorance' [Buchanan and Tullock (1962), Oates (1972) and Rawls (1972)]. Thus, suppose households cast their vote on the size of the intergovernmental transfer scheme T_j, $T_1 + T_2 = 0$ without knowing their actual income, but being aware of the income distribution from which they will make a draw in the 'lottery of life' after the constitution is written.[20]

Proposition 3. *Under the veil of ignorance, all individuals vote for decentralization and a constitutional interregional redistributive scheme $T_j^* \neq 0$, financed through local income tax revenues. In particular, a decentralized and asymmetric equilibrium characterized by*

$$(t_1^*, g_1^*) \leq (t_2^*, g_2^*) < (t_c^*, g_c^*), \quad \overline{Y}_1^* > \overline{Y}_2^*, \text{ and } \quad T_2^* = -T_1^* > 0,$$

exists and is unanimously *preferred to the outcome under centralization or decentralization without interregional redistribution, respectively.*

Proof. See Appendix A.

The intuition for this finding has already been laid out in the preceding discussion: while interjurisdictional redistribution may foster *interregional* inequality, it at the same time allows for more *interpersonal* equality among the regions' inhabitants, which reduces the inefficiencies inherent in the political process, thereby increasing the ex ante expected utility of households. The enhanced homogeneity of local populations is effective because political decisions are made and applied on the local level: policies in region 1 can be different from policies in region 2. This can make agents better off by allowing the provision of public services to be more in accordance with local individual preferences. In the classic theory on fiscal federalism [Oates (1972)], the positive welfare effects of a government 'closer to the people' are emphasized as the prominent reason to decentralize political responsibilities. Our model brings a new perspective to this argument by explicitly recognizing that, in the presence of migration, preference heterogeneity *across* regions must be treated as an equilibrium characteristic (as opposed to being exogenously given).

[20] It is possible that the transfer sustains more than one equilibrium outcome. In this case, preferences at the constitutional stage are not well defined and it is necessary to select among equilibria. We assume that individuals coordinate their expectations on the equilibrium that they prefer most (given a particular transfer scheme) when voting. Multiplicity of equilibria never occurred in numerical simulations of tax regimes with a lognormal distribution of income.

Constitutional Choice by Majority Vote

While voting under the 'veil of ignorance' has positive as well as normative appeal, in many situations citizens decide on the institutional structure governing interregional relations at a time where the individual stakes are already well known. Examples of such situations are the forming and the expansion of the European Union and German Unification. In both cases, voters were well informed about which country or region would contribute to the horizontal transfer scheme and which country or region would receive interregional aid. For this reason, it is important to ask whether interregional redistribution could be the outcome of a simple majority voting process when incomes are already known. The answer is yes, as the following proposition shows:

Proposition 4. *Suppose individual incomes y are already known at the constitutional stage. Then there exists a balanced interregional transfer scheme, $T_2^* = -T_1^* > 0$ (financed by local income tax revenues in the wealthy region), and an associated equilibrium with $(t_1^*, g_1^*) < (t_2^*, g_2^*)$, $\overline{Y}_1 > \overline{Y}_2$, and a boundary income $\tilde{y}$ that is preferred by a majority in* each *jurisdiction to the equilibrium that prevails under centralization or decentralization without horizontal transfers.*

Moreover, any such scheme $T_j^* \neq 0$ is supported by the wealthiest $\frac{1}{2}[1 - F(\tilde{y})]$ individuals in the population.

Proof. See Appendix A.

Thus, we find that there are interregional transfer schemes which make a majority of the population in each jurisdiction better off *even if the stakes are known.*[21] Moreover, and perhaps most surprisingly, the subgroup that always benefits from such schemes are the wealthiest individuals of the entire population. Intuitively, there are two effects that voters have to take into account when contemplating the choice between a federation without interregional transfers (which will result in the same uniform policy that would prevail in a centralized system) and a federation with a particular transfer scheme that supports interregional inequality. First, there is a *tax base* effect: agents with higher incomes will *ceteris paribus* be better off under a decentralized, unequal, system because they live in the region with the

[21] In light the situation in former West and East Germany, this result can be interpreted as follows: consider two separate countries for which integration is inevitable (e.g., migration becomes possible and citizens' rights have to be granted to immigrants). Then, the population will vote in favor of a federal constitution with inter-jurisdictional grants, rather than centralization.

higher average income (tax base). The converse is true for poorer individuals. Second, there is a *policy* effect. Under a decentralized scheme that supports interregional inequality, the local policies will be closer to the preferences of the local population, which is both more efficient and *ceteris paribus* tends benefit those individuals at the tails of the distribution in particular, i.e., those far away from the overall median who would determine policy otherwise. As the result shows, both effects are sufficient to have a majority in each region favoring a decentralized, equilibrium with asymmetric policies and population structures (supported by interregional transfers). Moreover, those at the top end of the income distribution stand to gain most since for them the tax base effect and the political effect work in the same direction.

Figure 2 illustrates the choice between no transfers, which corresponds to the case of homogeneous regions implementing the same policy (t_c^*, g_c^*), and a system with positive interregional transfers, which then support different local policies $(t_1^*, g_1^*) < (t_2^*, g_2^*)$ and interregional inequality $\bar{Y}_1 > \bar{Y}_2$. The curves with slopes $y_j^m/U'(g)$ are the indifference curves of the respective median voters in region j under the decentralized, unequal regime. The local budget lines have a slope of $\overline{Y}_j$ and intersect the vertical axis at T_j/α_j. Importantly, one can show that there is a transfer scheme and an associated asymmetric equilibrium in which (t_c^*, g_c^*) is within both regions' local budgets. Depending on the primitives of the model, this equilibrium may be one of two types: either both regions implement a policy bundle with less government activity [Figure 2 (a)] or the recipient jurisdiction spends more on the public good [Figure 2 (b)] than under financial independence.

In both cases (a) or (b), we see that there is no negative tax base effect: the unequal tax bases are fully compensated for by the interregional grant to equalize the fiscal budget at (t_c^*, g_c^*). As a consequence, only the policy effect operates and it follows immediately that the median voters in each region strictly prefer their local policy (t_j^*, g_j^*) in the asymmetric equilibrium to the common (central) policy (t_c^*, g_c^*) in the symmetric equilibrium. In an equilibrium as in Figure a), then, only the *poorest* individuals do not profit from the transfer sufficiently to be better off as with the bundle (t_c^*, g_c^*). The case depicted in Figure 2 (b), in contrast, displays a situation of 'edges against the middle'. Since government activity in the wealthy (poor) jurisdiction is lower (higher) with transfers than without, voters at the upper and lower end of the income distribution, respectively, favor the decentralized solution supported by interregional redistribution to the more moderate (homogeneous) policy implemented in the absence of the transfer.

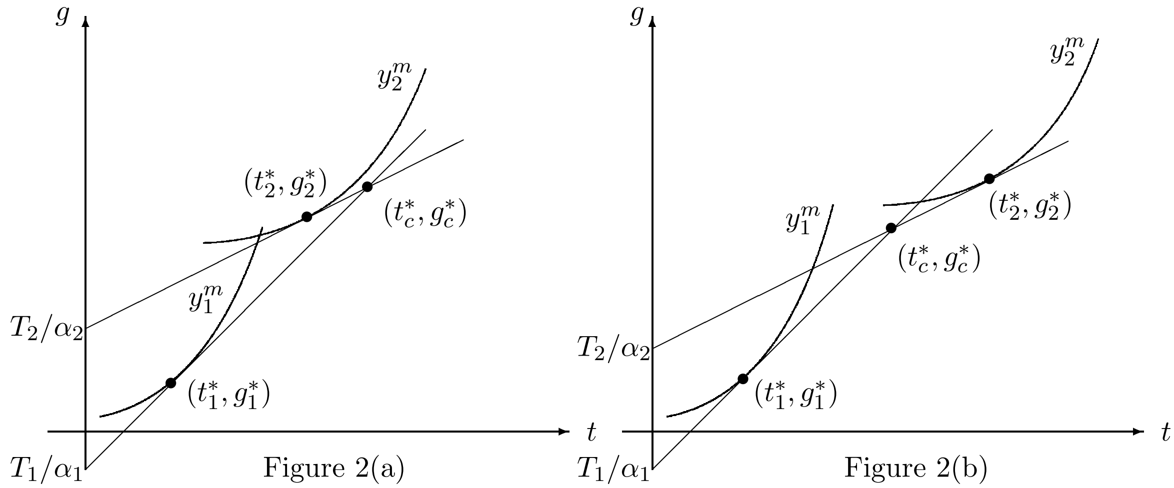

Figure 2(a) Figure 2(b)

In comparison, the two possibilities suggest that preferences over transfer schemes are neither single peaked nor do they vary monotonically with income. In general, therefore, there may be cases where a majority voting equilibrium over transfer schemes fails to exist. Intuitively, the problem stems from the fact that the equilibria supported by successively higher transfers have a non-monotonic effect on the well-being of individuals through the induced affect on public spending and the composition of each region.If an equilibrium exists, however, we know from Proposition 4 that it must be characterized by interregional redistribution. Moreover, the second and most remarkable part of the proposition states that the highest income individual always strictly prefer to pay the transfer, thereby preventing migration and keeping their policy bundle, rather than facing the migration induced political and budgetary changes that occur in the absence of the transfer.

4 Empirical Evidence

The model laid out in the previous sections yields two predictions regarding the relationship between inter-regional redistribution and (income) inequality. One of our central findings is that inter-regional transfers, by preventing migration, increase inter-*regional in*equality. A secondary implication is that they at the same time may help to promote inter-*personal* equality within the different regions of a federation.[22] This section investigates the impact

[22]The latter is not an unambiguous prediction of the model. Specifically, we cannot rule out the presence of equilibria in which transfers lead to more intra-regional inequality. However, those equilibria where the voting population deliberately uses transfer schemes to generate regional divergence are necessarily characterized by

of interregional transfers on interpersonal and interregional inequality using panel data on OECD countries as well as Canadian provinces. The different data sets are necessary since we are interested in different aspects of inequality (across regions versus within regions) at different territorial levels. To explore the impact of transfers on inter-regional inequality within federations, we employ data on a cross section of OECD countries. To study the relationship between transfers and intra-regional inequality, we need data on income inequality within the regions of a given federation that uses inter-regional transfers as a policy instrument. To our knowledge, Canada is the only federation that does so where comparable income Gini coefficients are available at the regional (provincial) level.

4.1 Transfers and Inter-regional Inequality

This section exploits the variation from a panel data set of 17 highly developed OECD countries covering the period from 1982 to 1999 to determine the effect of inter-regional redistribution on inter-regional inequality.[23] Unfortunately, we cannot simultaneously explore intra-regional inequality because regional level data on income inequality are generally not available. The only exception is Canada, which we will come back to in the subsequent section. Accordingly, we estimate variants of the following specification:

$$REGINEQ_{i,t} = \alpha_i + \sum_k \beta_k \cdot X_{k,i,t} + \gamma \cdot TRANSFERS_{i,t} + \mu_t + \epsilon_{i,t}, \quad (6)$$

were $REGINEQ_{i,t}$ denotes the level of interregional inequalities in each country, $X_{k,i,t}$ denotes k control variables, $TRANSFERS_{i,t}$ represents different measures of the level of intergovernmental transfers, and $\epsilon_{i,t}$ is a random error term. All variables are in 3-year period averages to eliminate of business cycle effects. Since the observed level of inter-regional inequality may vary with unobserved heterogeneity due to country-specific institutional or historical factors, or may be driven a common time trend, the model also includes country fixed effects (α_i) and year dummies (μ_t) respectively.

higher equality within regions and lower equality across regions [recall Proposition 4].

[23]The countries are: Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany (W.), Hungary, Ireland, Italy, Japan, Netherlands, Norway, Poland, Portugal, Slovakia, Spain, Sweden, Switzerland, United Kingdom, Unites States of America. The observation period ends in the year 1999 due to a change in the classifications of the IMF Government Finance Statistics (GFS) in 2001. Government finance data based on the new classifications are available from 1995 onwards. Since we are interested in long time-series data, we revert to data based on the standards for the compilation of statistics required for fiscal analysis that were established by the 1986 GFS Manual. See Kessler and Lessmann (2010) for further details.

We measure inter-regional inequality by the coefficient of variation of regional GDP per capita. The observations are taken from Lessmann (2009), and are based on NUTS2 level data for European countries and provincial level data otherwise. For the data on interregional transfers within countries we draw on the IMF Government Finance Statistics and the OECD Revenue Statistics. Our main explanatory variable of interest is $TRANSREV$, which are grants received by sub-national governments from other levels of government as share of total government revenues (excluding grants from abroad or supra-national institutions). As such, it reflects the extent of vertical as well as horizontal equalization. As a robustness check, we also consider an alternative indicator of intergovernmental redistribution, $TRANSAUT$, which denotes sub-national non-autonomous revenues as share of total government revenues (adjusted for sub-national transfers to other government levels).[24] By construction $TRANSAUT$ covers sub-national revenues from centrally-determined composite (or shared) taxes as well as horizontal and vertical transfers. This more comprehensive measure of transfers accommodates the fact that in some countries the apportionment of revenues from shared taxes on sub-national jurisdictions incorporates redistributive elements. In Germany, for example, the states (Bundesländer) receive 45% of the revenues from the national value-added tax. Up to 25% of this amount is given to those states whose per capita revenues from the income tax, the corporate tax and local state taxes is below the average of all states. Since our measure $TRANSAUT$ considers all non-autonomous revenues of sub-national governments it accounts for such horizontal tax redistributions.

The estimations include include a number of controls that have been shown in the literature to impact regional inequality. Following the suggestions of Williamson (1965) we control for national wealth as reflected by the GDP per capita ($GDPPC$) to account for the link between development and regional inequality. Country size and agglomeration effects are captured including the population size (POP), the Gini coefficient of the population distribution within a federation ($POPGINI$), and the degree of urbanization ($URBAN$). Moreover, we control for the size of the welfare state ($SOCIAL$) using government expenditures on public welfare as a share of GDP and we include the unemployment level ($UNEMPL$). Another determinant

[24]The calculation of this measure is more sophisticated as we need to know which sub-national revenues are determined autonomously. The OECD has developed an internationally comparable framework to assess the degree of control sub-national governments have over their revenues [see OECD (1999)]. Using this framework, we calculate the share of autonomous revenues of sub-national governments in total government revenues [see, e.g, Rodden (2004)]. The difference to the share of all sub-national government revenues in total government revenues provides us an indicator of subnational non-autonomous revenues.

of regional inequality is the degree of fiscal decentralization [McKinnon (1997), Qian and Weingast (1997)], which we consider using the share of sub-national government expenditures in total government expenditures ($EXPDEC$).[25]

The regression results are presented in Table 1. Columns (1) and (2) report the coefficients from two-way fixed effects OLS estimations using our alternative transfer measures $TRANSREV$ and $TRANSAUT$ respectively. As predicted by the model, the coefficients on both transfer measures are positive and strongly statistically significant. These results thus indicate that higher transfers are associated with more inter-regional inequality, which is consistent with the hypothesis that interregional transfers promote inter-regional inequalities. Of course, countries may react with an adjustment of transfers facing increasing interregional inequalities.To account for such a possible endogeneity and the resulting bias in the estimates, we also employ an instrumental variable approach using the one period (3 year) lagged value of the respective transfer measures as an instrument. The results of the corresponding 2SLS estimations are reported in columns (3) and (4). We see that the coefficient looses some of its value but remains positive, and significantly so for our transfer measure $TRANSAUT$, which is the more comprehensive proxy for interregional redistribution.

4.2 Transfers and Inter-personal Inequality

The theoretical model also implies that while transfers prevent inter-*regional* equality they at the same time allow for more inter-*personal* equality within the different regions of a federation. As mentioned above, regional-level data on income inequality are generally not available. Canada is an exception, however: the CANSIM database by Statistics Canada contains information on income inequality in the provinces (since 1976), information on interregional transfers between the federal and provincial/local level (since 1981) and information on several other determinants of inequality.[26] To study the relationship between interregional transfers and inter-personal inequality, we estimate variants of the following specification:

$$PERSINEQ_{i,t} = \alpha_i + \sum_k \beta_k \cdot X_{k,i,t} + \gamma \cdot TRANSFERS_t + \epsilon_{i,t}, \qquad (7)$$

[25]See table 9 in the appendix for data sources and definitions and table 10 for summary statistics of the relevant variables. See Kessler and Lessmann (2010) for further details of the empirical analysis and robustness checks.

[26]There are 10 provinces in Canada, and three territories. The latter are excluded from the data set, since Statistics Canada does not provide the relevant data on income inequality.

Table 1: *I*nter-regional inequality and equalization

	Dependent variable: Coefficient of variation of regional GDP per capita (*REGINEQ*)			
	OLS	OLS	TSLS	TSLS
	(1)	(2)	(3)	(4)
GDPPC	0.011***	0.009***	0.013***	0.012***
	(3.86)	(2.78)	(6.11)	(6.25)
UNEMPL	0.466***	0.423***	0.406***	0.315**
	(3.81)	(3.54)	(4.19)	(2.48)
POP	-0.436***	-0.457***	-0.388***	-0.518***
	(-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	-0.300*	-0.299*	-0.307	-0.129*
	(-1.80)	(-1.92)	(-1.55)	(-1.82)
SOCIAL	-0.001	-0.001	-0.001	-0.002
	(-0.92)	(-1.23)	(-0.78)	(-1.64)
DEC	-0.354***	-0.347***	-0.181*	-0.179*
	(-2.70)	(-2.63)	(-1.71)	(-1.94)
TRANSREV	0.232**		0.129	
	(2.37)		(0.36)	
TRANSAUT		0.235***		0.186**
		(3.47)		(2.55)
Country FE	yes	yes	yes	yes
Time FE	yes	yes	yes	yes
Observations[a]	92 (17)	91 (17)	77 (17)	74 (17)
Adj.-R^2	0.45	0.48	0.53	0.61
F-Test (p)	0.000	0.000	0.000	0.000

Note: *t*-values are reported in parenthesis; standard errors are calculated using White correction; ***, **, and * indicate significance at 1%, 5%, and 10%, respectively. a) Number of countries in parenthesis.

where the dependent variable $PERSINEQ_{i,t}$ is income inequality for province i in year t, α_i are provincial fixed effects, $X_{k,i,t}$ are k control variables, $TRANSFERS_t$ reflects different measures of intergovernmental transfers, and $\epsilon_{i,t}$ is a random error term.

We measure regional income inequality straightforwardly by the GINI coefficient of total household income in a province. Our different transfer measures are total intergovernmental transfers paid by the federal, provincial and local governments as a share of GDP (*TRANSGDP*), in per capita terms (*TRANSPC*), and as a share of total government revenues (*TRANSREV*). These variables approximate the level of intergovernmental redistribution and correspond to the redistributive grants in our theoretical model. The explanatory variables are demographic factors, using the logarithm of the total population (*POP*) and the share of the population over the age of 15 years (*SHARE15*), migration effects using the net immigration rate (*MIGRATION*), and labor market effects using the unemployment rate (*UNEMPL*) as well as the female labor participation rate (*FEMPART*). To control for the impact of economic development on inequality [Kuznets (1955)] we also include GDP per capita (*GDPPC*).[27]

The estimated coefficients are reported in table 2. Columns (1) to (3) give the results of the fixed effects OLS regressions. Consistent with the theory, the coefficients of all three alternative transfer measures are negative and significant: the higher the level of intergovernmental transfers, the lower is interpersonal income inequality within each province. To address autocorrelation in the residuals, we ran additional regressions which include three-year lags of dependent variable.[28] The results of corresponing OLS estimates are reported in columns (4) to (6). Again, all transfer variables all enter the regression with a negative sign and are highly significant.

It is known that in dynamic fixed-effects panel models the correlation between the error term and the lagged dependent variables might lead to biased and inconsistent estimates of the parameters [Baltagi (2005)]. Although the problem is unlikely to be serious in our case since the number of agents (N) is relatively small compared to the number of time series observations (T), we use the Arellano-Bond dynamic panel estimator to ensure that our results are unbiased. The results are reported in columns (7) to (9), which, again, support

[27]See table 4 in the appendix for exact variable definitions; summary statistics of all considered variables provides table 5. We applied several unit root tests to our dependent variable, which all negate the existence of a common or individual unit root. See table 6 in the appendix for details.

[28]A Durbin-Watson test rejects the null that the error terms are serially uncorrelated. The lag length of three time periods was chosen based on the Akaike information criterion.

our earlier findings. A last step in our empirical investigation is to ensure that our results are not driven by a common time trend. For this purpose, we repeat all estimations considering a common trend variable as additional control, with unchanged results [see Table 7 in the Appendix]. Overall, the data indicate a robust negative relationship between the level of overall transfers and the level of income inequality within the Canadian provinces. These findings are clearly consistent with the secondary implication of the model, namely that transfers can decrease inter-*personal* equality within the different regions of a federation.

Of course, the natural question to ask next is whether the evidence from Canada also supports the main prediction model, i.e., displays a pattern of higher transfers leading to more inter-*regional* inequality, fostering divergence among regions. Shedding light on this issue with the Canadian data proves difficult, however. The reason is that relating the coefficient of variation as a measure of income inequality among the provinces to the level of transfers results in just one single time series, which severely limits the scope of the econometric analysis. We provide the descriptive statistics for illustration purposes in Table 3, which gives an overview of the development of the two variables over time.

Table 2: Inter*personal* inequality and equalization in Canadian provinces (1981–2007)

	Dependent variable: Gini coefficient of total incomes at provincial level								
	OLS	OLS	OLS	OLS	OLS	OLS	GMM	GMM	GMM
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
GINI L1				0.460***	0.469***	0.451***	0.446***	0.454***	0.438***
				(10.34)	(10.66)	(11.51)	(9.69)	(10.24)	(10.55)
GINI L2				0.128*	0.136**	0.140**	0.120**	0.127**	0.132**
				(2.18)	(2.31)	(2.38)	(2.13)	(2.29)	(2.34)
GINI L3				-0.123**	-0.123**	-0.107*	-0.128***	-0.127***	-0.113**
				(-2.38)	(-2.40)	(-2.01)	(-2.86)	(-2.83)	(-2.43)
POP	0.065**	0.074***	0.060**	0.034**	0.039***	0.028**	0.031***	0.037***	0.026**
	(2.97)	(3.23)	(2.69)	(2.91)	(3.53)	(2.44)	(2.55)	(3.16)	(2.13)
SHARE15	0.252***	0.259***	0.262***	0.125*	0.125*	0.126**	0.125**	0.127**	0.123**
	(3.98)	(3.91)	(4.15)	(2.21)	(2.18)	(2.61)	(2.0)	(2.15)	(2.22)
MIGRATION	0.022	-0.154	-0.039	-0.005	-0.122	-0.029	-0.016	-0.132	-0.047
	(0.12)	(-0.69)	(-0.19)	(-0.04)	(-0.76)	(-0.17)	(-0.12)	(-0.88)	(-0.32)
FEMPART	-0.001	-0.001	-0.001*	-0.001	0.000	-0.001**	-0.001*	0.000	-0.001***
	(-1.60)	(-1.07)	(-2.11)	(-1.77)	(-0.83)	(-2.60)	(-1.82)	(-0.70)	(-2.79)
UNEMPL	0.001	0.001	0.001	0.001*	0.001	0.001	0.001**	0.001	0.001*
	(1.74)	(1.11)	(1.36)	(1.85)	(1.31)	(1.64)	(2.06)	(1.57)	(1.83)
GDPPC	0.014*	0.020**	0.016**	0.007**	0.011***	0.008**	0.008***	0.012***	0.009***
	(2.24)	(2.80)	(2.40)	(2.75)	(3.65)	(2.90)	(3.76)	(4.97)	(3.86)
TRANSGDP	-0.481***			-0.334***			-0.342***		
	(-3.11)			(-3.41)			(-3.60)		
TRANSPC		-0.139**			-0.109***			-0.114***	
		(-2.57)			(-3.11)			(-3.42)	
TRANSREV			-0.179**			-0.135***			-0.135***
			(-2.78)			(-3.50)			(-3.59)
Constant	-0.684*	-0.841**	-0.603	-0.337*	-0.438**	-0.258	-0.299	-0.406**	-0.218
	(-2.09)	(-2.52)	(-1.76)	(-1.91)	(-2.60)	(-1.41)	(-1.51)	(-2.11)	(-1.09)
Province FE	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations[a]	270 (10)	270 (10)	270 (10)	270 (10)	270 (10)	270 (10)	260 (10)	260 (10)	260 (10)
Adj.-R^2	0.65	0.65	0.66	0.75	0.75	0.75			
AR(2)-Test (p)							0.34	0.36	0.36

Note: *t*-values are reported in parenthesis; standard errors are calculated using White correction; ***, **, and * indicate significance at 1%, 5%, and 10%, respectively. a) Number of provinces in parenthesis

Table 3: Inter*regional* inequality and equalization in Canada

Period	Coefficient of Variation (CV)	Transfers to GDP ($TRANSGDP$)	Transfers per capita ($TRANSPC$)	Transfers to revenues ($TRANSREV$)
1980s	0.210	0.082	2241 C $	0.204
1990s	0.204	0.077	2338 C $	0.175
2000s	0.182	0.064	2332 C $	0.157

Note: Transfers in constant CAD 2002. In the regression analysis, transfers per capita are related to 10,000 people.

During the 1980s, the coefficient of variation was on average 0.21, which equal almost exactly the average of the OECD countries [see Lessmann (2009)]. In the two decades that followed, the dispersion of regional income decreased slightly indicating σ-convergence between provinces. At the same time, transfers became relatively less important for the Canadian economy, both in terms of the transfers to GDP rate as well as in terms of the transfers to government revenue. From this perspective, the evidence is supportive of our main hypothesis. However, the amount of transfers per capita evolved in the opposite direction, contradicting the previous observation. The ambiguity of the relationship between transfers and interregional inequality also surfaced when we conducted standard time series regressions. Those did not show any significant effects.[29] In light of this, we are not able to confirm - or refuse - the model with the Canadian data. This should come as no surprise, though, given that we only have a single time series with 10 provinces at our disposal, which does not provide enough observations to control for the various determinants of interregional inequality.

However, previous studies using a different methodological approach do support the prediction that inter-regional redistribution has led to more (rather than less) inter-regional inequality in Canada. In particular, Coulombe and Day (1999) compare the evolution of income inequality among the Canadian provinces to that among the 12 U.S. states along the Canadian southern border. Although this reference group exhibits extensive similarities in terms of history, geography, institutions, stage of development, and economic structure, the authors present evidence that regional disparities – as measured by the coefficient of variation – are 50% higher in Canada compared to the U.S. regions. They convincingly argue that the primary reason behind the difference in outcomes is the systematically lower labor

[29]See table 8 in the Appendix for the results of the time series estimations for Canada.

force 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].[30]

5 Concluding Remarks

The present paper puts forward two main ideas. Perhaps most importantly, we first show that inter-jurisdictional redistribution need not be an appropriate instrument to equalize living standards among federation members: in the presence of migration, the paradoxical situation arises that horizontal transfers from wealthy to poor states preserve regional inequalities that otherwise could not persist. The analysis also demonstrates, however, that interregional transfers may have positive efficiency effects in this case. While preventing inter*regional* equality between members of the federation they at the same time could promote more inter*personal* equality between the inhabitants of each jurisdiction. An initial empirical assessment of the relationship between inter-regional redistribution and income disparity across and within regions is consistent with these effects. On the one hand, higher levels of inter-regional redistribution are positively associated with (future) regional income disparities in a panel of highly developed OECD countries. On the other hand, inter-regional redistribution is negatively associated with intra-regional income inequality within a single country (Canada).

That horizontal transfers may allow populations with different political tastes to be separated from one another and be subjected to different fiscal treatments has positive welfare implications: stratification of the population according to income classes can be a welfare enhancing equilibrium pattern. For this reason, interregional redistribution could be desirable from an ex ante point of view: when incomes are not yet known at the constitutional stage, a sufficiently risk neutral population unanimously favors a decentralized form of organization

[30]Another study on the factors leading to convergence among Canadian provinces is Rodriguez (2006). On the basis of a comprehensive time-series analysis for the period 1926-1999, 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].

where jurisdictions are politically independent but financially linked through transfers from rich to poor communities. Perhaps surprisingly, this organizational mode is also preferred by a majority ex post. Low income individuals benefit if the loss in local public spending due separation is compensated for by the intercommunity transfer. Wealthy individuals are always better off because they gain most from living among their own kind: they strictly prefer to pay the horizontal transfer, thereby preserving a homogeneous population structure and keeping taxes low.

Many efficiency concerns about stratified population classes have recently been raised in the fiscal federalism literature. In Fernandez and Rogerson (1996), policies that increase the number of the wealthiest residents in poor communities generate a Pareto improvement. The authors consider a model with only three income classes, and assume that the equilibrium in the absence of any transfer is already stratified.[31] It is then possible to construct a redistributive transfer in a way that will constitute a Pareto improvement.[32] Applied to the U.S. system of school finance, for instance, Fernandez and Rogerson's analysis would thus suggest that appropriately designed equalization grants of the form used by most U.S. states to aid local funding for primary and secondary education unambiguously benefit all school districts, and can in principle serve to reduce the observed spending disparities across districts. Our analysis, in contrast, shows that these equalization grants can have very different effects: if the equilibrium is not stratified in the absence of a grant system, the movements of households caused by its introduction will always change average regional income in opposite directions. Hence, it never constitutes a Pareto improvement (in particular, middle class households will tend to loose). Moreover, equalization grants may in fact contribute to the spending disparities in the sense that removing them triggers migration that will ultimately bring about more equality among school districts (rather than less).

De Bartholomé (1990) addresses the negative externalities that arise from stratification in the presence of local peer effects. Benabou (1996) studies in a dynamic model of human capital

[31] As we have shown elsewhere, however, stratification is generically impossible for realistic income distribution that are skewed to the right and unimodal [see Hansen and Kessler (2001a) as well as the Proof of Proposition 1 in Appendix A.

[32] By inciting more middle-class households to live among the poor, the transfer makes the poor community better off because per-capita revenues have unambiguously increased, causing the tax rate to drop and local spending to rise. The rich community is better off if the transfer has a similar effect there, i.e., if local taxes drop and spending increases despite the loss in revenues. This happens if the increase in average income and the decrease in local income inequality brought about by the emigration of middle-class households is sufficient large.

accumulation where stratification negatively affects long run income inequality and growth. This paper shows that there is another aspect of stratification related to distortions caused by conflicting interest in the political process that are lower under segregation. In particular, local policies are more distortive the more heterogenous the local populations are. Segregation (supported by interregional redistribution) lowers the degree of local heterogeneity, thereby mitigating the political conflict of interest.[33]

Our conclusions have been drawn in a relatively simple framework that was designed to permit an analytic evaluation of the policies under consideration. However, it should be clear that they apply more generally as well. Extending the model to allow for migration cost, for instance, is fairly straightforward and will preserve all results as long as those cost are sufficient small and enter the (indirect) utility function in a separable manner.[34] Likewise, provided taxation is redistributive in nature, the equilibrium often does not permit stratification in the absence of transfers even if one explicitly accounts for housing price differences or in situations where wealthy individuals prefer more public spending than the poor [Hansen and Kessler (2001a,2001b)] as will, e.g., be the case for public education with no private alternative. Then, interregional redistributive serves to maintain interregional differences by weakening the incentives of the poor to migrate to wealthier regions. Again, local income (preference) inequality will be lower in a stratification equilibrium supported by transfers, implying that political conflicts of interest are minimized: local policies are - irrespective of their specific nature - 'close' to the preferences of *all* inhabitants.

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[33] In Benabou (1996), sorting may have positive short run effects if family background and school quality are complements in a child's education. In the presents of skills complementarities and decreasing returns to human capital, however, any positive (local) effect of sorting will be outweighed by the negative (global) effect of an unequal distribution of skills in the long run. He concludes that a centralized school finance, which in his model is equivalent to integrated society, is socially desirable. Our model does not incorporate the dynamics of human capital accumulation, and thus necessarily ignores the negative effects of sorting on growth that Benabou identifies. Our analysis also suggests, though, that centralization may be a better alternative than decentralization with equalization transfers in reforming school finance if integration is the policy objective.

[34] We wish to thank Daron Acemoglu for pointing this out to us.

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Appendix A

Lemma 1. *Suppose $T_j = 0$, $j = 1, 2$. Then, there is no equilibrium in which regions conduct different policies $(t_1^*, g_1^*) \neq (t_2^*, g_2^*)$.*

Proof. Consider any asymmetric equilibrium $\{(t_j^*, g_j^*), f_j^*(y)\}_{j=1,2}$. As explained in the main text, any such equilibrium must be characterized 'descending bundles' and 'stratification'. By convention, we let $(t_1^*, g_1^*) < (t_2^*, g_2^*)$ so that $f_1^*(y) = f(y)\ \forall y > \tilde{y}$ and $f_2^*(y) = f(y)\ \forall y < \tilde{y}$ for some boundary individual $\tilde{y} \in [\underline{y}, \bar{y}]$. Since $g_1^{\max} = \overline{Y}_1^* > \overline{Y}_2^*$ contradicts $g_1^* < g_2^*$, g_1^* must be determined by (4), $U'(g_1^*) = \sigma_1$. $g_1^* < g_2^*$ and Lemma 3 a) [see Appendix B] thus imply $U'(g_2^*) \leq U'(g_1^*) \leq 1$ at any $\tilde{y} \in [\underline{y}, \bar{y}]$. Then, $V(t_1^*, g_1^*, \tilde{y}) - V(t_2^*, g_2^*, \tilde{y}) = (t_2^* - t_1^*)\tilde{y} - [U(g_2^*) - U(g_1^*)] = (t_2^* - t_1^*)\tilde{y} - \int_{g_1^*}^{g_2^*} U'(g)dg \geq (t_2^* - t_1^*)\tilde{y} - (g_2^* - g_1^*) = t_2^*(\tilde{y} - \bar{Y}_2^*) - t_1^*(\tilde{y} - \bar{Y}_1^*) > 0$ using $T_j = 0$, (2) and $\overline{Y}_2 < \tilde{y} < \overline{Y}_1$. Hence, an individual with income $\tilde{y}$ would always be better off in region 1, contradicting the equilibrium condition that $\tilde{y}$ is the boundary agent.□ □

Lemma 2. *The set $\mathcal{Y} = \{\tilde{y} | \sigma_1(\tilde{y}) \geq \sigma_2(\tilde{y})\} \subset [\underline{y}, \overline{y}]$ is non-empty. Furthermore, $\sigma_c < \sigma_2(\hat{y}) = \sigma_1(\hat{y}) \leq 1$ at some $\hat{y} \in \mathcal{Y}$.*

Proof. To show that $\mathcal{Y}$ is non- empty, note that y_j^m and $\overline{Y}_j, j = 1, 2$ are continuous in $\tilde{y}$ over $[\underline{y}, \bar{y}]$, and so are $y_j^m / \overline{Y}_j, j = 1, 2$. Since

$$\begin{aligned} &\lim_{\tilde{y} \to \underline{y}} \tfrac{y_1^m}{\overline{Y}_1} = \tfrac{y_c^m}{\overline{Y}_c} < 1, \quad \lim_{\tilde{y} \to \underline{y}} \tfrac{y_2^m}{\overline{Y}_2} = \tfrac{\underline{y}}{\underline{y}} = 1, \\ &\lim_{\tilde{y} \to \bar{y}} \tfrac{y_1^m}{\overline{Y}_1} = \tfrac{\bar{y}}{\bar{y}} = 1, \qquad \lim_{\tilde{y} \to \bar{y}} \tfrac{y_2^m}{\overline{Y}_2} = \tfrac{y_c^m}{\overline{Y}_c} < 1, \end{aligned}$$

there exist a value $\hat{y}$ for which $\frac{y_1^m}{\overline{Y}_1} = \frac{y_2^m}{\overline{Y}_2}$ at $\tilde{y} = \hat{y}$, and $\frac{y_1^m}{\overline{Y}_1} > \frac{y_2^m}{\overline{Y}_2}$ for $\tilde{y} > \hat{y}$, implying $[\hat{y}, \bar{y}] \subset \mathcal{Y}$.

To prove the second part of Lemma 2, observe first that although we know that the average slope of $\frac{y_1^m}{\overline{Y}_1}$ ($\frac{y_2^m}{\overline{Y}_2}$) over $[\underline{y}, \bar{y}]$ is positive (negative) from the arguments above, neither expression needs to be monotonically related to $\tilde{y}$ over this range (so that the claim would follow trivially). Instead, we will show that

$$1 \geq \frac{y_1^m}{\overline{Y}_1} = \frac{y_2^m}{\overline{Y}_2} > \frac{y_c^m}{\overline{Y}_c},$$

at $y = \hat{y}$. That both median to mean ratios are weakly smaller than one at $\tilde{y} = \hat{y}$ is implied by Lemma 3 a) (see Appendix B). It therefore suffices to show that at $y = \hat{y}$,

$$\begin{aligned} \frac{y_1^m}{\overline{Y}_1} > \frac{y_c^m}{\overline{Y}_c} \quad &\Leftrightarrow \quad y_c^m < \frac{y_1^m}{\overline{Y}_1} \overline{Y}_c = \frac{y_1^m}{\overline{Y}_1} \left\{ [(1 - F(\hat{y})] \overline{Y}_1 + F(\hat{y}) \overline{Y}_2 \right\}. \\ &\Leftrightarrow \quad y_c^m < [1 - F(\hat{y})] y_1^m + F(\hat{y}) y_2^m, \end{aligned}$$

where the second equivalence follows from substituting $\overline{Y}_2 = \frac{y_2^m}{y_1^m} \overline{Y}_1$ and rearranging. If $f(y)$ is unimodal, $F(y)$ is convex (concave) for $y < y_c^M$ ($y > y_c^M$) where y_c^M is the mode of the distribution with $f'(y_c^M) = 0$. The subsequent arguments establish that this property implies

$$y_c^m < [1 - F(\tilde{y})] y_1^m + F(\tilde{y}) y_2^m, \tag{8}$$

for all values $\tilde{y}$ such that $y_2^m / \overline{Y}_2 \leq 1$ and hence, for $\tilde{y} = \hat{y}$ as well.

First, we show that for all values $\tilde{y}$ such that $y_2^m / \overline{Y}_2 \leq 1$,

$$F(y_1^m) < F(y_2^m) + f(y_2^m)(y_1^m - y_2^m). \tag{9}$$

If $y_2^m \geq y_c^M$, (9) follows immediately from the concavity of $F(\cdot)$ over the considered range. Thus, suppose $y_2^m \leq y_c^M$. From Lemma 3 b) and c) (see Appendix B), we know that due to $y_2^m / \overline{Y}_2 \leq 1$ at $\tilde{y}$,

$$F(\tilde{y}) \leq F(y_2^m) + f(y_2^m)(\hat{y} - y_2^m) \quad \text{and} \quad \tilde{y} > y_c^M.$$

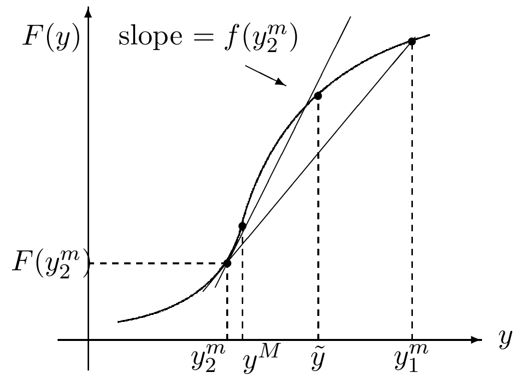

Figure 3

Figure 3 graphically illustrates the situation. Because $F(\cdot)$ is strictly concave $\forall y > y_c^M$, these two inequalities imply (see Figure 3) that

$$F(y) < F(y_2^m) + f(y_2^m)(y - y_2^m) \quad \forall y > \tilde{y}.$$

Since $y_1^m > \tilde{y}$, (9) follows. Intuitively, the unimodality of $f(\cdot)$ requires $\tilde{y}$ to lie strictly to the right of y_c^M for the median to mean ratio in the poor community to be less than one. As a consequence, the distribution function $F(\cdot)$ is (at least on average) concave for $y \in [y_2^m, y_1^m]$ and (9) holds.

Next, (9) implies that the line connecting $F(y_2^m)$ with $F(y_1^m)$ with slope $[F(y_1^m) - F(y_2^m)/(y_1^m - y_2^m) < f(y_2^m)$ must cut $F(\cdot)$ at $y = y_2^m$ from below. Hence (see also Figure 3),

$$F(y) > F(y_2^m) + \frac{F(y_1^m) - F(y_2^m)}{y_1^m - y_2^m}(y - y_2^m), \qquad \forall y \in (y_2^m, y_1^m).$$

In particular, this must be true for $y = y_c^m$ and therefore

$$\begin{aligned} F(y_c^m) \quad &> \quad F(y_2^m) + \frac{F(y_1^m) - F(y_2^m)}{y_1^m - y_2^m}(y_c - y_2^m) \\ \Leftrightarrow \quad y_c^m \quad &< \quad [1 - F(\tilde{y})]y_1^m + F(\tilde{y})y_2^m, \end{aligned}$$

after rearranging and using $F(y_c^m) = \frac{1}{2}$, $F(y_2^m) = \frac{1}{2}F(\tilde{y})$, and $F(y_1^m) = \frac{1}{2}[1 + F(\tilde{y})]$. □

Proof of Proposition 2:
We show that for each boundary individual $\tilde{y} \in \mathcal{Y}$, there exists a inter-jurisdictional transfer scheme $T_2(\tilde{y}) = -T_1(\tilde{y}) > 0$ supporting the allocation

$$\begin{aligned} f_1^*(y) \quad &= \quad \begin{cases} f(y) & \text{for } y > \tilde{y}, \\ 0 & \text{otherwise,} \end{cases} \\ f_2^*(y) \quad &= \quad \begin{cases} 0 & \text{for } y > \tilde{y}, \\ f(y) & \text{otherwise,} \end{cases} \end{aligned} \tag{10}$$

as a the population structure in a stratification equilibrium. Let $T_2 = -T_1 \equiv T > 0$ be the transfer from jurisdiction 1 to jurisdiction 2 and define $\Delta : [\underline{y}, \bar{y}] \times \mathbb{R}^+ \to \mathbb{R}$ as the utility difference between jurisdiction 1 and jurisdiction 2 of a boundary household $\tilde{y}$, given the transfer T. $\Delta(\tilde{y}, T)$ is continuous in T with

$$\Delta(\tilde{y}, T) = U(g_1^*) - U(g_2^*) + [t_2^*(\tilde{y}, T) - t_1^*(\tilde{y}, T)]\, \tilde{y}$$

where the equilibrium policies and their properties are determined by (4). If $\Delta(\cdot) = 0$ a stratification equilibrium exists for $(\tilde{y}, T)$ if in addition $(t_1^*, g_1^*) \leq (t_2^*, g_2^*)$ holds. The latter requirement is important because even though $\tilde{y}$ may be indifferent, we still need to ensure that the population settles according to (10) and not vice versa.

Now consider some $\tilde{y} \in \mathcal{Y}$ so that $\sigma_2 \leq \sigma_1$ by Lemma 2. Then, $g_1^* \leq g_2^*$ from (4) as long as $g_2^* \neq g_2^{\max}$. Thus, for $T = 0$, either $g_1^* \leq g_2^*$ and $t_1^* < t_2^*$ or, if $g_1^* > g_2^*$ then $g_2^* = g_2^{\max}$ and $t_1^* \leq t_2^* = 1$. In both cases, $\Delta(\tilde{y}, T = 0) > 0$ follows (either by Lemma 1 or trivially).
We can now establish the existence of $T(\tilde{y})$ by an intermediate value argument. Suppose first that $g_1^* \leq g_2^*$ at $\tilde{y} \in \mathcal{Y}$ and $T = 0$. Then, (4) must hold in jurisdiction 1 ($g_1^* = g_1^{\max}$ implies $g_2^* = g_2^{\max}$ which is inconsistent with $g_1^* \leq g_2^*$). Increasing T thus leaves g_1^* unchanged and only increases t_1^* up to $t_1^* = 1$. In jurisdiction 2, a rise in T is accompanied by a reduction in t_2^*, leaving g_2 unaffected or else increasing for $t_2^* = 1$. For any $\tilde{y} \in \mathcal{Y}$, therefore, there is a transfer $\overline{T} > 0$ such that $g_1^* \leq g_2^*$ and $t_1^* = t_2^*$. At $T = \overline{T}$, $\Delta(\tilde{y}, T = \overline{T}) \leq 0$ so that $\Delta(\tilde{y}, T(\tilde{y})) = 0$ at some $T(\tilde{y}) \in (0, \overline{T}]$. Furthermore, the inequalities $g_1^* \leq g_2^*$ and $t_1^* \leq t_2^*$ are preserved at $T(\tilde{y})$ and the claim follows.
Second, suppose $g_1^* > g_2^*$ at $\tilde{y} \in \mathcal{Y}$ and $T = 0$, implying $g_2^* = g_2^{\max}$ and $t_2^* = 1$. Now, increasing T first increases t_1^* (for $g_1^* < g_1^{\max}$) until $t_1^* = 1$ and $g_1^* = g_1^{\max}$ and then reduces g_1^*. Similarly, g_2^* increases, leaving $t_2^* = 1$ unaffected until (4) just holds at some $\overline{T}$. Since $U'(g_2^*) = \sigma_2 \leq \sigma_1 \leq U'(g_1^*)$, we must have $g_1^* \leq g_2^*$ at this point with $t_1^* = t_2^* = 1$. Again, $\Delta(\tilde{y}, T = \overline{T}) \leq 0$ implying $\Delta(\tilde{y}, T(\tilde{y})) = 0$ at some $T(\tilde{y}) \in (0, \overline{T}]$. Furthermore, since $t_j^* = 1$ at $T(\tilde{y})$, $\Delta(\tilde{y}, T(\tilde{y})) = 0$ requires $g_1^* = g_2^*$, again preserving the inequality $(t_1^*, g_1^*) \leq (t_2^*, g_2^*)$. The claim follows.□

Proof of Corrollary 2. Let $\alpha^* = \int f_j^*(y)dy$ be the equilibrium mass of individuals in j and consider a small pertubation of j's population structure with $\hat{\alpha} = \alpha^* - \epsilon$ and $\epsilon > 0$. To establish (5) for any given value of μ and arbitrary perturbations of the local population $\{\hat{f}_j(y)\}_{j=1,2}$ with $\int_{\underline{y}}^{\overline{y}} f_j(y) - \int_{\underline{y}}^{\overline{y}} \hat{f}_j(y) = \epsilon$, we proceed to show that the regional policy in the perturbed population distribution, $(\hat{t}_j, \hat{g}_j)$, is a continuous function of ϵ and will converge to the equilibrium policy (t_j^*, g_j^*) as $\epsilon \to 0$. This implies that condition (5) is satisfied with strict inequality for any $\mu > 0$ as $\epsilon \to 0$; in particular, (5) holds even for y-type individuals y for whom $V(t_j^*, g_j^*, y) = V(t_k^*, g_k^*, y)$ in equilibrium as ϵ becomes sufficiently small.

By definition of $\hat{\overline{Y}}_j$ and $\overline{Y}_j^*$, we have

$$\overline{Y}_j^* - \hat{\overline{Y}}_j = \frac{1}{\alpha} \int_{\underline{y}}^{\overline{y}} y f_j^*(y) dy - \frac{1}{\hat{\alpha}} \int_{\underline{y}}^{\overline{y}} y \hat{f}_j(y) dy \tag{11}$$

Clearly, the pertubations

$$\hat{f}_j(y) = \begin{cases} f_j^*(y) & \text{for } y \leq \tilde{y}, \\ 0 & \text{otherwise}, \end{cases} \int_{\hat{y}}^{\overline{y}} y f_j(y) dy = \epsilon \tag{12}$$

and

$$\hat{f}_j(y) = \begin{cases} f_j^*(y) & \text{for } y \geq \tilde{y}, \\ 0 & \text{otherwise}, \end{cases} \int_{\underline{y}}^{\hat{y}} y f_j(y) dy = \epsilon. \tag{13}$$

constitute an upper (respectively, lower) bound on the change in average perturbed incomes. Noting $\hat{\alpha} < \alpha$ and using (11) and (12), we thus have

$$\overline{Y}_j^* - \hat{\overline{Y}}_j \leq \frac{1}{\hat{\alpha}} \int_{\underline{y}}^{\overline{y}} y \left(f_j(y) - \hat{f}_j(y) \right) dy = \frac{1}{\hat{\alpha}} \int_{\hat{y}}^{\overline{y}} y f_j(y) dy \leq \frac{\epsilon \overline{y}}{\alpha - \epsilon} \tag{14}$$

Similarly, using (11) and (13),

$$\overline{Y}_j^* - \hat{\overline{Y}}_j \geq \frac{1}{\alpha}\int_{\underline{y}}^{\overline{y}} y\left(f_j(y) - \hat{f}_j(y)\right)dy = \frac{1}{\alpha}\int_{\underline{y}}^{\hat{y}} y f_j(y) dy \geq -\frac{\epsilon \underline{y}}{\alpha}. \tag{15}$$

Turning to the change in the medians, recall that by definition, $F_j^*(y_j^{m*}) = \frac{1}{2}\alpha$ and $\hat{F}_j(y_j^m) = \frac{1}{2}\hat{\alpha}$ where $F_j^*(y)$ (respectively, $\hat{F}_j(y)$) is the cdf characterizing the equilibrium (respectively, perturbed) population structure in j. Hence, $F_j^*(y_j^{m*}) - \hat{F}_j(\hat{y}_j^m) = \frac{1}{2}\epsilon$, which implies

$$\left|\hat{F}_j(y_j^{m*}) - \hat{F}_j(\hat{y}_j^m)\right| \leq \frac{1}{2}\epsilon$$

due to $0 \leq F_j^*(y_j^{m*}) - \hat{F}_j(\hat{y}_j^m) \leq \epsilon$ (there is more mass in F_j^* than in $\hat{F}_j$ and some of it may be below $\hat{y}_m$ but the total below $\hat{y}_m$ cannot exceed ϵ). Using a first-order expansion of $\hat{F}_j(\hat{y}_j^m)$, we get

$$\hat{f}_j(\hat{y}_j^m)\left|y_j^{m*} - \hat{y}_j^m\right| \leq \frac{1}{2}\epsilon. \tag{16}$$

Finally, note that (12), (13), and (16) imply

$$\lim_{\epsilon\to 0}\overline{Y}_j^* - \hat{\overline{Y}}_j = \lim_{\epsilon\to 0} y_j^{m*} - \hat{y}_j^m = 0,$$

which in turn implies $\hat{t}_j^* \to t_j^*$ and $\hat{g}_j \to g_j^*$ as $\epsilon \to 0$. Hence,

$$\lim_{\epsilon\to 0} V(\hat{t}_j, \hat{g}_j, y) = V(t_j^*, g_j^*, y) \qquad \forall y,\ \forall \hat{f}_j(y),\ \forall (t_j^*, g_j^*).$$

Now consider a symmetric equilibrium for which $V(t_j^*, g_j^*, y) = V(t_k^*, g_k^*, y)\ \forall y$. We find

$$\lim_{\epsilon\to 0} V(\hat{t}_k, \hat{g}_k, y) - V(\hat{t}_j, \hat{g}_j, y) = V(t_k^*, g_k^*, y) - V(t_j^*, g_j^*, y) = 0 < \mu.$$

Thus, (5) is satisfied with strict inequality for sufficiently small values of ϵ. For a stratification equilibrium, the same line of reasoning shows that (5) holds for boundary individuals $\tilde{y}$. For all other individuals, the equilibrium conditions already require $V(t_j^*, g_j^*, y) > V(t_k^*, g_k^*, y)$ for all types y with $f_j^*(y) > 0$, which again implies that (5) holds for small enough ϵ. □

Proof of Proposition 3:
Since everybody is alike ex ante, all conflicts of interest are eliminated and there will be unanimity in voting over the constitution. We represent the preferences of agents at the constitutional stage by the Von Neumann-Morgenstern utility function

$$E\left[u(c,g)\right] = \int_{\underline{y}}^{\bar{y}} [c + U(g)] f(y)\, dy.$$

where E is the expectation operator and $u(\cdot)$ is the utility from consuming (g, c) which depends on the income being drawn by nature and the subsequent equilibrium. Take any $\tilde{y} \in \mathcal{Y}$ for which $1 \geq \sigma_1(\tilde{y}) \geq \sigma_2(\tilde{y}) > \sigma_c$ (note that there is at least one such value by Lemma 2). Proposition 2 then implies there exists an associated equilibrium characterized by $g^e \leq g_1^* \leq g_2^* < g_c^*$ supported by some transfer scheme $T_2 = -T_1 = T(\hat{y}) > 0$ where the last strict inequality follows from (4), the proof of Proposition 2, and the assumption that g_c^* is implicitly defined by $U'(g_c^*) = \sigma_c$. We proceed to show that the expected utility difference between the continuation equilibria $\{(t_j^*, g_j^*)\}$ and (t_c^*, g_c^*) is strictly positive. Multiplying the (binding) budget constraint in region j by α_j^* and adding up yields

$$\sum\nolimits_{j=1}^{2} \alpha_j^* g_j^* = \sum\nolimits_{j=1}^{2} \alpha_j^* t_j^* \overline{Y}_j^* \tag{17}$$

Each individual's difference in expected utility at the constitutional stage is

$$\begin{aligned}
&E_y\left[V(t_j^*, g_j^*, y) - V(t_c^*, g_c^*, y)\right] \\
&= \int_{\underline{y}}^{\tilde{y}} \left[U(g_2^*) + (1-t_2^*)y - U(g_c^*) - (1-t_c^*)y\right] f(y)\,dy \\
&\quad + \int_{\tilde{y}}^{\bar{y}} \left[U(g_1^*) + (1-t_1^*)y - U(g_c^*) - (1-t_c^*)y\right] f(y)\,dy \\
&= \alpha_2^* \left[U(g_2^*) - t_2^*\overline{Y}_2^* - U(g_c^*) + t_c^*\overline{Y}_c\right] + \alpha_1^* \left[U(g_2^*) - t_1^*\overline{Y}_1^* - U(g_c^*) + t_c^*\overline{Y}_c\right] \\
&= \sum\nolimits_{j=1}^{2} \alpha_j^* \left[U(g_j^*) - g_j^* - U(g_c^*) + g_c^*\right] \qquad \text{by (17)} \\
&= \sum\nolimits_{j=1}^{2} \alpha_j^* \left[g_c^* - g_j^* - \int_{g_j^*}^{g_c^*} U'(g)dg\right] \qquad > 0 \quad \text{for} \quad U'(g_c^*) < U'(g_j^*) \le 1,\ j = 1,2. \square
\end{aligned}$$

Proof of Proposition 4:
We show that there exists a transfer scheme $T_2(\tilde{y}) = -T_1(\tilde{y}) > 0$ and an associated stratification equilibrium with $\tilde{y}$ and $(t_1^*, g_1^*) < (t_2^*, g_2^*)$ such that $(t_c^*, g_c^*) \neq (t_j^*, g_j^*)$ is a feasible policy in *each* jurisdiction given its budget. By revealed preference and strict concavity, both local median voters must then strictly prefer their local policies (t_j^*, g_j^*) to (t_c^*, g_c^*) and the first claim follows.
Let $\tau_2(\tilde{y}) = -\tau_1(\tilde{y}) = \tau(\tilde{y}) > 0$ be necessary the transfer for the centrally chosen policy to lie on the budget line of both jurisdictions for a partition of the population at $\tilde{y}$, i.e.

$$\begin{aligned}
g_c^* = t_c^*\overline{Y}_c = t_c^*\overline{Y}_1^* - \tau(\tilde{y})/\alpha_1^* = t_c^*\overline{Y}_2^* + \tau(\tilde{y})/\alpha_2^* \\
\Leftrightarrow \qquad \tau(\tilde{y})/\alpha_1^* = t_c^*(\overline{Y}_1^* - \overline{Y}_c) \quad \text{and} \quad \tau(\tilde{y})/\alpha_2^* = t_c^*(\overline{Y}_c - \overline{Y}_2^*).
\end{aligned} \tag{18}$$

The per capita transfers $\tau(\tilde{y})/\alpha_j^*$ are continuously increasing (decreasing) functions of $\tilde{y}$ for community 1 (2): as $\tilde{y}$ increases, the wealthy community must pay more and the poor community receives less in per capita terms.
It remains to show that $\tau(\tilde{y})$ supports an equilibrium with $(t_1^*, g_1^*) < (t_2^*, g_2^*)$. From Proposition 2 and the proof of Lemma 2 (first part), we know that $\forall \tilde{y} > \hat{y}$, $\exists T_2(\tilde{y}) = -T_1(\tilde{y}) = T(\tilde{y}) > 0$ supporting such an equilibrium. Thus, it suffices to find a boundary individual $\tilde{y} \ge \hat{y}$ for which $T(\tilde{y}) = \tau(\tilde{y})$ holds.
Step 1: $\quad \tau(\hat{y}) > T(\hat{y})$.
Observe that under a transfer scheme $\tau(\hat{y})$, $g_j^{\max} = (1-t_c^*)\overline{Y}_j + t_c^*\overline{Y}_c > g_c^*$, $j = 1,2$. Hence, $U'(g_j^{\max}) < U'(g_c^*) = \sigma_c < \sigma_j$ at $\tilde{y} = \hat{y}$ from Lemma 2 (second part) and thus, $g_j^* < g_j^{\max}$, $j = 1,2$. Now reconsider the utility difference of the boundary household between region 1 and region 2 $\Delta(\hat{y}, T)$ for a transfer $\tau(\hat{y})$. Recalling that $U'(g_2^*) = \sigma_2 = \sigma_1 = U'(g_1^*)$ at $\hat{y}$ and using (18) together with $g_1^* = g_2^* \equiv g^* < g_c^* = t_c^*\overline{Y}_c$, one finds

$$\begin{aligned}
\Delta[\hat{y}, \tau(\hat{y})] &= (t_2^* - t_1^*)\hat{y} \\
&= \left[\frac{1}{\overline{Y}_2^*}(g^* + \tau/\alpha_2^*) - \frac{1}{\overline{Y}_1^*}(g_c^* - \tau/\alpha_1^*)\right]\hat{y} \\
&= \frac{1}{\overline{Y}_1^*\overline{Y}_2^*}\left(\overline{Y}_1^* - \overline{Y}_2^*\right)(g^* - g_c^*)\hat{y} \quad < 0 \quad \text{for} \quad g^* < g_c^*.
\end{aligned}$$

Thus, the individual $\hat{y}$ strictly prefers to live in region 2 for $\tau(\hat{y})$. Since $T(\hat{y})$ makes this individual indifferent by definition, $T(\hat{y}) < \tau(\hat{y})$ as claimed.

Step 2: $\lim_{\tilde{y}\to\overline{y}} \tau(\tilde{y}) < \lim_{\tilde{y}\to\overline{y}} T(\tilde{y})$.
Note first that as $\tilde{y} \to \overline{y}$, $\overline{Y}_2 \to \overline{Y}_c$, $y_2^m \to y_c^m$, $\overline{Y}_1 \to \overline{y}$ and $y_1^m \to \overline{y}$. Also, $\lim_{\tilde{y}\to\overline{y}} \tau(\tilde{y})/\alpha_1^* = t_c^*(\overline{y} - \overline{Y}_c)$ and $\lim_{\tilde{y}\to\overline{y}} \tau(\tilde{y})/\alpha_2^* = 0$ from (18). The equilibrium public good levels are therefore [see (4)],

$$\lim_{\tilde{y}\to\overline{y}} g_1^* = g^e \qquad \text{and} \qquad \lim_{\tilde{y}\to\overline{y}} g_2^* = g_c^*.$$

Recall that $g^e < g_c^*$ is feasible in region 1 by definition of $\tau(\cdot)$. Inserting the expression for $\tau(\tilde{y})$ into the budget constraint (2) for region 1, we find $\lim_{\tilde{y}\to\overline{y}} (t_1^* - t_c^*)\overline{y} = g^e - g_c^*$. In the limit, the utility difference $\Delta(\tilde{y}, T)$ of the boundary individual $\tilde{y} \to \overline{y}$ for a transfer $T = \tau(\tilde{y})$ is accordingly

$$\begin{aligned}\lim_{\tilde{y}\to\overline{y}} \Delta[\tilde{y}, \tau(\tilde{y})] &= U(g^e) - U(g_c^*) - (t_1^* - t_c^*)\overline{y} = U(g^e) - U(g_c^*) - (g^e - g_c^*) \\ &= g_c^* - g^e - \int_{g^e}^{g_c^*} U'(g)dg \qquad > 0 \quad \text{for} \quad U'(g_c^*) < U'(g^e) = 1.\end{aligned}$$

Hence, the individual $\tilde{y} \to \overline{y}$ strictly prefers to live in region 1 given the transfer $\tau(\tilde{y})$. By definition of $T(\tilde{y})$, we must therefore have $\lim_{\tilde{y}\to\overline{y}} \tau(\tilde{y}) < \lim_{\tilde{y}\to\overline{y}} T(\tilde{y})$ as claimed. Combining steps 1 and 2, the existence of a boundary individual $\overline{y} > \tilde{y} > \hat{y}$ for which $T(\tilde{y}) = \tau(\tilde{y})$ follows from an intermediate value argument.

To prove the second part of Proposition 4, we show that is impossible to have an equilibrium with $(t_2^*, g_2^*) \geq (t_1^*, g_1^*) \geq (t_c^*, g_c^*)$. Hence, $(t_1^*, g_1^*) < (t_c^*, g_c^*)$ and the claim follows.
Below, we argue that $\sigma_1 \geq \sigma_2$ is necessary for an equilibrium with $(t_2^*, g_2^*) \geq (t_1^*, g_1^*)$. It thus suffices to show that there does not exist a boundary individual $\tilde{y}$ such that

$$\sigma_2(\tilde{y}) \leq \sigma_1(\tilde{y}) \leq \sigma_c.$$

The proof is by contradiction. Suppose that there exists such a $\tilde{y}$. We thus must have

$$\alpha \frac{y_2^m}{\overline{Y}_2} + (1-\alpha)\frac{y_1^m}{\overline{Y}_1} < \frac{y_c^m}{\overline{Y}_c} \qquad \alpha \in [0,1], \tag{19}$$

at this partition of the population. In particular, (19) must hold for $\alpha = \frac{F(\tilde{y})\overline{Y}_2}{\overline{Y}_c}$ and thus becomes

$$F(\tilde{y})y_2^m + [1 - F(\tilde{y})]y_1^m < y_c^m,$$

which contradicts (8) [see the proof of Lemma 3 and recall that (8) holds for all $\tilde{y}$ such that $y_2^m/\overline{Y}_2 \leq 1$].

It remains to demonstrate that $\sigma_1 \geq \sigma_2$ at some partition of the population $\tilde{y} \in [\underline{y}, \overline{y}]$ is also necessary for an asymmetric equilibrium. By way of contradiction, we show if $\sigma_1 < \sigma_2$, then $(t_1, g_1) \leq (t_2, g_2)$ is violated for any transfer scheme $T_2 = -T_1 \equiv T$. From (4), $\sigma_1 < \sigma_2 \Rightarrow g_1^* > g_2^*$ irrespective of T if $g_1^* \neq g_1^{\max}$. Thus, we must have $g_1^* = g_1^{\max}$ and $t_1^* = 1$, so that $(t_1, g_1) \leq (t_2, g_2)$ can only hold if $t_2^* = 1$ and $g_2^* = g_1^{\max}$, which together with the local budget constraints (2) implies $g_1^{\max} = \overline{Y}_c > g_c^*$. Thus, $g_j^* = g_1^{\max}$ requires $\sigma_1 < \sigma_2 \leq U'(g_1^{\max}) < U'(g_c^*) = \sigma_c$. But a situation where $\sigma_1 < \sigma_2 \leq \sigma_c$ is impossible (see our argument above). □

Appendix B (not to be published)

Let $F(y)$ be a twice continuously differentiable distribution function that represents the income distribution of the population with $y_c^m < \overline{Y}_c$. Furthermore, assume that the associated density function $f(y)$ satisfies $f(y) > 0$, $\forall y \in [\underline{y}, \overline{y}]$ and $f'(y) > 0$ ($f'(y) < 0$) for $y < y_c^M$ ($y > y_c^M$), i.e. $f(y)$ is unimodal with mode y_c^M. Under these assumptions, we prove

Lemma 3. *Suppose $\tilde{y}$ partitions the population such that individuals $y > \tilde{y}$ live in region 1 and individuals $y \leq \tilde{y}$ live in region 2. Let y_j^m and $\overline{Y}_j$ be the local median and mean incomes, respectively, at the partition $\tilde{y}$. Then,*

a) $\frac{y_1^m}{\overline{Y}_1} \leq 1 \qquad \forall \tilde{y} \in [\underline{y}, \overline{y}]$,

b) $\frac{y_2^m}{\overline{Y}_2} \leq 1 \Rightarrow F(\tilde{y}) \leq F(y_2^m) + f(y_2^m)(\tilde{y} - y_2^m)$,

c) $\frac{y_1^m}{\overline{Y}_1} = \frac{y_2^m}{\overline{Y}_2} \Rightarrow \tilde{y} > y_c^M$,

<u>Proof:</u> Note first that

$$\overline{Y}_1 = \frac{1}{1-F(\tilde{y})} \int_{\tilde{y}}^{\overline{y}} y f(y) dy = \frac{1}{1-F(\tilde{y})} \left\{ \overline{y} - F(\tilde{y})\tilde{y} - \int_{\tilde{y}}^{\overline{y}} F(y) dy \right\}, \tag{20}$$

$$\overline{Y}_2 = \frac{1}{F(\tilde{y})} \int_{\underline{y}}^{\tilde{y}} y f(y) dy = \frac{1}{F(\tilde{y})} \left\{ F(\tilde{y})\tilde{y} - \int_{\underline{y}}^{\tilde{y}} F(y) dy \right\}, \tag{21}$$

by partial integration. Furthermore,

$$1 - F(y_1^m) = \frac{1}{2}[1 - F(\tilde{y})] = F(y_1^m) - F(\tilde{y}) \tag{22}$$

$$F(y_2^m) = \frac{1}{2} F(\tilde{y}) \tag{23}$$

These expressions are well defined and continuously differentiable in $\tilde{y}$. To prove part a) consider the local median to mean ratio in the wealthy region 1. From (20), we infer

$$\frac{y_1^m}{\overline{Y}_1} \leq 1 \quad H(\tilde{y}) \equiv \int_{\tilde{y}}^{\overline{y}} F(y) dy + F(\tilde{y})\tilde{y} - \overline{y} + [1 - F(\tilde{y})] y_1^m \leq 0. \tag{24}$$

Taking derivatives of $H(\tilde{y})$, using (22) and $\partial y_1^m / \partial \tilde{y} = \frac{1}{2}[f(\tilde{y})/f(y_1^m)]$, we obtain

$$\frac{\partial H(\tilde{y})}{\partial \tilde{y}} \gtreqless 0 \quad \Leftrightarrow \quad F(y_1^m) - f(y_1^m)(y_1^m - \tilde{y}) \gtreqless F(\tilde{y}).$$

If $f(y)$ is unimodal, $F(y)$ is convex (concave) for $y < y_c^M$ ($y > y_c^M$). Thus, $H(\tilde{y})$ is strictly decreasing in $\tilde{y}$ for values $y_1^m(\tilde{y}) \leq y_c^M$ and strictly increasing in $\tilde{y}$ for $\tilde{y} \geq y_c^M$. As some value $\tilde{y}^{\min}$ from the intermediate range with $\tilde{y}^{\min} < y_c^M < y_1^m(\tilde{y}^{\min})$, $H(\tilde{y})$ assumes a unique minimum. To see this, note that $H''(\tilde{y}^{\min}) = -f'(y_1^m)(y_1^m - \tilde{y}^{\min}) + f(y_1^m) - f(\tilde{y}^{\min}) > 0$ at any $\tilde{y}^{\min}$ satisfying $H'(\tilde{y}^{\min}) = 0$ since $y_1^m(\tilde{y}^{\min}) > y_c^M$ implies $f'(y_1^m) < 0$ and $H'(\tilde{y}^{\min}) = 0$ implies $f(y_1^m) - f(\tilde{y}^{\min}) > 0$, where the last inequality follows from the fact that the line connecting $F(y_1^m)$ and $F(\tilde{y})$ with slope $[F(y_1^m) - F(\tilde{y}^{\min})]/[y_1^m - \tilde{y}^{\min}]$ must cut $F(\tilde{y}^{\min})$ from above (since $\tilde{y}^{\min} < y_c^M$) and, hence, $f(\tilde{y}^{\min}) < [F(y_1^m) -$

$F(\tilde{y}^{\min})]/[y_1^m - \tilde{y}^{\min}] < f(y_1^m)$.
Now, recall that $y_c^m - \overline{Y}_c < 0$ by assumption so that (24) holds for $\tilde{y} \to \underline{y}$. Similarly, (24) is trivially satisfied for $\tilde{y} \to \overline{y}$. The monotonicity properties of $H(\tilde{y})$ then imply that (24) also holds for any intermediate values.

To prove part b), we first examine for which values of $\tilde{y}$, we have

$$\frac{y_2^m}{\overline{Y}_2} \leq 1 \quad \Leftrightarrow \quad G(\tilde{y}) \equiv \int_{\underline{y}}^{\tilde{y}} F(y)dy - F(\tilde{y})(\tilde{y} - y_2^m) \leq 0, \tag{25}$$

by (21). Again, we are interested in the derivative of $G(\tilde{y})$. Using (23) and $dy_2^m/d\tilde{y} = \frac{1}{2}[f(\tilde{y})/f(y_2^m)]$ yields

$$\frac{\partial G(\tilde{y})}{\partial \tilde{y}} \gtreqless 0 \quad \Leftrightarrow \quad F(\tilde{y}) \gtreqless F(y_2^m) + f(y_2^m)(\tilde{y} - y_2^m). \tag{26}$$

Repeating the argument on the slope of $H(\cdot)$ in the proof of part a), we see that $G(\tilde{y})$ is strictly increasing (decreasing) in $\tilde{y}$ for $\tilde{y}$ less (greater) than some value $\tilde{y}^{\max}$ satisfying $y_2^m(\tilde{y}^{\max}) < y_c^M < \tilde{y}^{\max}$. Furthermore, $G(\tilde{y} = \underline{y}) = 0$ and $G(\tilde{y} = \overline{y}) < 0$. The function $G(\cdot)$ is therefore downward sloping in the range where its values are non-positive, i.e., we must have $\partial G(\cdot)/\partial \tilde{y} \leq 0$ for all values $\tilde{y}$ such that $G(\tilde{y}) \leq 0$. Using (26) and (25), it follows that

$$\frac{y_2^m}{\overline{Y}_2} \leq 1 \Rightarrow F(\tilde{y}) \leq F(y_2^m) + f(y_2^m)(\tilde{y} - y_2^m),$$

as claimed. Finally, observe that because $y_1^m/\overline{Y}_1 \leq 1$ for all values $\tilde{y} \in [\underline{y}, \overline{y}]$, we must also have $y_2^m/\overline{Y}_2 \leq 1$ at $\tilde{y} = \hat{y}$ by definition of $\hat{y}$. Thus, b) holds at $\tilde{y} = \hat{y}$ which implies

$$\hat{y} > \tilde{y}^{\max} > y_c^M,$$

which proves part c). □

Table 4: Variable definitions and sources – panel of Candian provinces (1981–2007)

Variable	Definition	Source
GINI	Gini coefficient of total income in Canadian provinces	CANSIM
POP	Total Provincial population (in 10,000 people)	CANSIM
SHARE15	Populations share over 15 years of age	CANSIM
MIGRATION	Net immigration per capita	CANSIM
FEMPART	Female labor market participation rate	CANSIM
UNEMPL	Unemployment rate	CANSIM
GDPPC	Real gross domestic product per capita (Canadian Dollar, 2002)	CANSIM
TRANSGDP	Total intergovernmental transfers (federal, provincial and local) as share of GDP	CANSIM
TRANSPC	Total intergovernmental transfers (federal, provincial and local) per capita (10,000 people)	CANSIM
TRANSREV	Total intergovernmental transfers (federal, provincial and local) as share of total government revenues	CANSIM, OECD World Economic Outlook

Table 5: Summary statistics – Canadian Provinces (1981-2007)

	Observations	Mean	Std. Dev.	Maximum	Minimum
GINI	270	0.394	0.020	0.440	0.347
POP (in 10,000 people)	270	287.6	334.0	1279.5	12.4
SHARE15	270	0.770	0.028	0.838	0.698
MIGRATION	270	-0.001	0.005	0.016	-0.019
FEMPART	270	56.5	5.8	67.6	39.4
UNEMPL	270	10.1	3.8	20.2	3.4
GDPPC (in 10,000 $)	270	2.864	0.730	5.334	1.587
TRANSGDP	270	0.075	0.010	0.089	0.059
TRANSPC	270	0.233	0.020	0.279	0.201
TRANSREV	270	0.179	0.026	0.216	0.136

Table 6: Panel unit root tests of the Gini coefficient

Method	Statistics	p-values
(1) Levin-Lin-Chu Test	-7.19	0.000
(2) Breitung t-stat	-3.92	0.000
(3) Im-Pesaran-Shin Test	-5.62	0.000
(4) ADF-Fisher Test	64.95	0.000
(5) PP-Fisher Test	67.44	0.000

Note: Test (1) and (2) assume a common unit root process. Test (3), (4) and (5) assume an individual unit root process. All tests are calculated using individual effects and individual linear trends. The tests have the null-hypothesis of a unit root. The number of lags is determined by Schwarz-Criteria. Probabilities of the Fisher-Test are asymptotically chi-square distributed. All other tests assume a normal distribution.

Table 7: Inter*personal* inequality and equalization in Canadian provinces (1981–2007)

	Dependent variable: Gini coefficient of total incomes at provincial level								
	OLS	OLS	OLS	OLS	OLS	OLS	GMM	GMM	GMM
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
GINI L1				0.438 ***	0.439 ***	0.436 ***	0.433 ***	0.432 ***	0.430 ***
				(8.71)	(8.93)	(9.37)	(8.52)	(8.66)	(9.24)
GINI L2				0.126 *	0.131 *	0.137 **	0.123 **	0.126 **	0.133 **
				(2.09)	(2.14)	(2.27)	(2.12)	(2.16)	(2.30)
GINI L3				-0.119 **	-0.117 **	-0.108 *	-0.120 ***	-0.118 ***	-0.109 **
				(-2.41)	(-2.39)	(-2.11)	(-2.71)	(-2.71)	(-2.37)
POP	0.035	0.037	0.034	0.018	0.019 ***	0.017	0.018	0.019 *	0.016
	(1.59)	(1.67)	(1.51)	(1.73)	(1.95)	(1.57)	(1.64)	(1.79)	(1.47)
SHARE15	0.203 **	0.200 **	0.215 **	0.103	0.099	0.108 *	0.109	0.104	0.112
	(2.39)	(2.29)	(2.76)	(1.63)	(1.56)	(1.99)	(1.72)	(1.65)	(2.01)
MIGRATION	0.147	0.047	0.082	0.066	-0.007	0.030	0.083	0.000	0.037
	(1.10)	(0.31)	(0.53)	(0.50)	(-0.05)	(0.21)	(0.67)	(0.01)	(0.28)
FEMPART	-0.002 ***	-0.002 ***	-0.002 ***	-0.001 ***	-0.001 ***	-0.001 ***	-0.001 ***	-0.001 ***	-0.001 ***
	(-4.51)	(-4.46)	(-4.59)	(-5.58)	(-4.72)	(-5.20)	(-5.36)	(-4.07)	(-5.28)
UNEMPL	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001 *
	(1.71)	(1.13)	(1.30)	(1.76)	(1.29)	(1.54)	(2.05)	(1.55)	(1.79)
GDPPC	0.005	0.008	0.007	0.003	0.005	0.004	0.003	0.005	0.005
	(0.67)	(0.95)	(0.90)	(0.68)	(1.14)	(1.03)	(0.90)	(1.57)	(1.32)
TRANSGDP	-0.364 **			-0.274 **			-0.285 ***		
	(-2.52)			(-2.84)			(-3.13)		
TRANSPC		-0.120 **			-0.100 **			-0.104 ***	
		(-2.32)			(-2.84)			(-3.12)	
TRANSREV			-0.130 *			-0.111 **			-0.114 ***
			(-2.12)			(-2.86)			(-3.13)
TREND	0.001 **	0.002 ***	0.001 **	0.001 **	0.001 **	0.001 **	0.001 **	0.001 ***	0.001 *
	(2.95)	(3.14)	(2.92)	(2.56)	(2.89)	(2.11)	(2.26)	(2.54)	(1.86)
Constant	-0.177	-0.211	-0.164	-0.066	-0.096	-0.052	-0.071	-0.100	-0.053
	-0.50	-0.61	-0.46	-0.38	-0.58	-0.29	-0.38	-0.53	-0.28
Province FE	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations[a]	270 (10)	270 (10)	270 (10)	270 (10)	270 (10)	270 (10)	260 (10)	260 (10)	260 (10)
Adj.-R^2	0.67	0.67	0.67	0.75	0.75	0.75			
AR(2)-Test (p)							0.45	0.46	0.45

Note: *t*-values are reported in parenthesis; standard errors are calculated using White correction; ***, **, and * indicate significance at 1%, 5%, and 10%, respectively. a) Number of provinces in parenthesis

Table 8: Estimation results: Inter*regional* inequality and equalization in Canada

	Dependent variable: Coefficient of variation (CV) of provincial GDP per capita		
	OLS	OLS	OLS
	(1)	(2)	(3)
CV L1	0.338**	0.383**	0.341**
	(2.11)	(2.40)	(2.34)
GDPPC	0.000**	0.000**	0.000***
	(-2.24)	(-2.25)	(-2.83)
TRANSGDP	-0.330		
	(-1.01)		
TRANSPC		-0.051	
		(-0.49)	
TRANSREV			-0.122
			(-1.12)
Constant	0.225***	0.178***	0.220***
	(2.84)	(2.97)	(3.48)
Obs.	26	26	26
Adj.-R^2	0.65	0.64	0.65
F-Test (p)	0.000	0.000	0.000

Note: t-values are reported in parenthesis; standard errors are calculated using White correction; ***, **, and * indicate significance at 1%, 5%, and 10%, respectively.

Table 9: Variable definitions and sources – OECD panel

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
TRANSREV	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
TRANSAUT	Sub-national non autonomous revenues as share of total government revenues adjusted for sub-national transfers to other government levels	OECD Revenue Statistics and IMF Government Finance Statistics
GDPPC	Real gross domestic product per capita (US Dollar)	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 10: Summary statistics – OECD panel (1982–1999; 3-year averages)

COV	101	0.207	0.081	0.071	0.420
TRANSREV	99	0.132	0.052	0.016	0.245
TRANSAUT	95	0.155	0.100	0.024	0.394
GDPPC (1.000 $)	102	17.6	5.1	6.8	30.9
UNEMPL	99	0.086	0.044	0.008	0.229
POP (Mill.)	102	36.8	61.5	3.5	275.2
POPGINI	102	0.375	0.127	0.173	0.635
URBAN	102	0.745	0.123	0.389	0.972
SOCIAL	102	15.8	3.6	9.8	26.3
DEC	96	0.383	0.146	0.091	0.700