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Redistributing Income Under Fiscal Vertical Imbalance

Vincenzo Verardi, Laurent Bouton and Marjorie Gassner

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Redistributing Income Under Fiscal Vertical Imbalance*

Laurent Bouton - ULB (ECARES, CEE)†
Marjorie Gassner - ULB (ECARES, CEE)‡
Vincenzo Verardi - ULB (ECARES, CEE) and FUNDP Namur§

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Abstract

From the literature on decentralization, it appears that the fiscal vertical imbalance is somehow inherent to multi-level governments. Using a stylized model we show that this leads to a reduction in the extent of redistributive fiscal policies if the maximal tolerable size of government has been reached. To test for this empirically we use some high quality data, from the LIS dataset, on individual incomes. The results are highly significant and point in the direction of our theoretical predictions.

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†Université Libre de Bruxelles (European Center for Advanced Reasearch in Economics and Statistics, Centre de l'Economie de l'Education), CP-139. Av. F.D. Roosevelt, B-1050, Brussels, Belgium. Correponding author. E-mail:lbouton@ulb.ac.be. tel: +32 (0) 2 650 38 41. fax: +32 (0) 2 650 44 75. Mini-arc fellowship.

‡Université Libre de Bruxelles (European Center for Advanced Reasearch in Economics and Statistics, Centre de l'Economie de l'Education), CP-139. Av. F.D. Roosevelt, B-1050, Brussels, Belgium. E-mail:mgassner@ulb.ac.be.

§Université Libre de Bruxelles (European Center for Advanced Reasearch in Economics and Statistics, Centre de l'Economie de l'Education) and Faculté Universitaire Notre Dame de la Paix Namur (Center for Research in Economic Development), CP-139. Av. F.D. Roosevelt, B-1050, Brussels, Belgium. E-mail:vverardi@ulb.ac.be.

1 Introduction

In OECD countries, on average more than 30% of government expenditures are decentralized. On the other hand, only 20% of revenues are collected at the sub-national level. This means that one third of local expenditures need to be financed by central grants. From the literature on decentralization, it appears that this disequilibrium (which we will refer to from here on, as the *fiscal vertical imbalance*) is somehow inherent to multi-level governments: while decentralizing expenditures is considered efficient in fitting local preferences (Tiebout, 1957; Oates, 1972), decentralizing revenues is generally viewed as dangerous. Tax differentials could lead to a polarization of the economic activity or even to a race to the bottom in taxation (see Zodrow and Mieszowski, 1986 and Wildasin,1989) inducing an underprovision of public goods. In fact, only taxes associated with non-mobile bases may be assigned to sub-national governments.

To some extent, this vertical imbalance fosters fiscal indiscipline since it separates spending from revenue responsabilities. Sub-national governments will tend to overspend given that they share the burden of their expenditures with the other entities (the famous common pool problem). It might be argued that one way to tackle the problem is to allow the central government to fix the budget of sub-national governments. Unfortunately, even if this idea is appealing, it turns out to be difficult to implement in practice. Indeed, the central government faces huge incentives to soften the sub-national budget constraint (see Wildasin, 2004; Goodspeed, 2002 and Akai and Sato, 2005). An interesting example is given by Wildasin (2004): if local entities face a "hard budget constraint" (the national government sets the amount given to sub-national ones), but can choose the composition of expenditures, their dominant strategy would be to concentrate all of the expenditures on local public goods that do not generate cross-border externalities. In such a way, there would be an underprovision of the externality generating goods and the central government would be obliged to intervene. This behavior of sub-national governments induces a softening of the budget constraints because they get an additional financing of local goods with respect to what was originally planned. Petterson-Lidbom and Dahlberg (2003), using Swedish data, corroborate this idea empirically.[1] Another interesting and complementary argument against a central government setting the budget of sub-national governments is proposed by Weingast et al. (1981). Their idea is that, even if the sub-national budget is fixed at the national level, it is the result of a logrolling procedure (in the

[1] For other empirical evidence sustaining this idea, see Borge and Rattso (2003) and Rodden (2003).

national legislative assembly), where legislators (that have local interests) exchange votes to guarantee that their pork-barrel project can be financed. In other words, the (different) parties anticipate the hard constraint and incorporate all desired expenses into the budget through the legislative process. The result is that the "hard budget constraint", thus imposed by the Parliament, is in fact no different from a budget constraint that is flexible ex-post. Baqir (2002) and Knight (2004) among others, show that this argument is confirmed empirically.

If we accept that vertical imbalance leads to excessive local expenditures, an interesting question to raise is what happens when the government has reached its maximal tolerable size?[2] Our idea is that there will be a replacement of national (redistributive) expenditures by local (non-redistributive) ones[3] and this will affect the capacity of the State to redistribute incomes negatively. The intuition is that, in case of vertical imbalance, sub-national entities increase their local public goods spending since they share the burden of the expenditure with the others. Then, if the maximal tolerable size of government is reached, the increase of sub-national expenditures is impossible without sacrificing other expenditures. In particular, there will be a replacement of national government (redistributive) expenditures by local ones.

To formalize this idea, we present a stylized theoretical model where the national government is exclusively in charge of income redistribution and local entities provide local public goods. What we show is that the introduction of fiscal vertical imbalance, induces a substitution of redistributive central spending by non-redistributive local expenditures and, ceteris paribus, a decrease of the reduction in income inequality. We then present empirical evidence, using a high quality dataset based on individual incomes in OECD countries, that supports this prediction.

The structure of the paper is the following: in section 2 we present the model; in section 3, we describe the data and the empirical methodology; in section 4 we present the empirical results and in section 5 we conclude.

[2] In line with the idea of maximal tolerable size of government proposed by Peacock and Wiseman (1961).

[3] Even if there are some arguments in favor of local redistribution (see Pauly, 1973; Ashworth et al., 2002), the common view is that the national government should be in charge of income redistribution (see Oates, 1968 and 1972; Brown and Oates, 1987; Wildasin, 1991; Epple and Romer, 1991; Feldstein and Wrobel, 1998). Note that in practice, most redistribution is decided at the national level.

2 The Model

We build a stylized model of a two-level government where the upper (national) level is in charge of redistribution and the lower (sub-national) level is in charge of the provision of non-redistributive (pork-barrel) local public goods.[4] The decisions regarding taxing and spending are taken in accordance with the preferences of the median voters[5]: national decisions are taken in function of the national median voter while sub-national decisions are made in function of the sub-national median voters. To isolate the effect that fiscal irresponsability has on the redistribution of income, we compare two extreme situations: first, the *vertical imbalance* case, where only the central government taxes (at a rate τ_f^{VI}) and the budget of sub-national levels is exclusively guaranteed through grants (G) and second, the *vertical balance* case, where each level is in charge of raising the ressources necessary to finance its own expenditures (the national government taxes at a rate τ_f^{VB} while the sub-national government of region k taxes at a rate τ_k). Redistribution is ensured through raising proportional taxes and redistributing a lump-sum amount F to all individuals countrywide.

We consider a country composed of K distinct regions indexed by $k = 1, ..., K$, each of which has a population of size N^k. The country's total population is $N = \sum_{k=1}^{K} N^k$. Individuals are assumed to be identical in all dimensions, except for their initial level of income. Let y^{ik} denote the initial level of income of individual i in region k.

2.1 National financing of sub-national expenditures

As argued in the introduction, to some extent, vertical imbalance leads to the common pool problem. In other words, the national government explicitly or implicitly, accomodates the demands of sub-national levels. For the sake of simplicity, we model this by assuming that the national government accepts all of the financial demands of sub-national entities (i.e., full accomodation). This assumption could be somewhat relaxed (assuming only partial accomodation) but the model would lead to similar results while becoming unecessarily complicated.

The utility function of individual i in region j is assumed to be of the quasi-linear form $w^{ij} = c^{ij} + H(g^j)$ where c^{ij} is his disposable income (or private consumption of the *numeraire*), and g^j is the per capita supply of the local public good of region j. Function

[4] Results do not change if we allow national government to have a greater role than just redistributing income.

[5] See Black (1948). Assuming a benevolant dictator leads to the comparable results.

$H(\cdot)$ is assumed to be strictly increasing and strictly concave with $H(0) = 0$. Disposable income c^{ij} is equal to $y^{ij}(1-\tau_f^{VI})+F-C(F)$, where the redistribution cost function $C(\cdot)$ is assumed to be strictly convex. At least two reasons support the introduction of these costs in the model: first, income restribution systems (which are particularly difficult to manage) induce bureaucracy costs that must be taken into account. Second, it is a very convenient way to take into account the distortions that redistribution induces on the labor market, without complicating the model unecessarily.

Since the national government is in charge of both redistributive expenditures and the financing of sub-national spending on local public goods (through grants), its budget constraint is:

$$\sum_k \sum_i F + \sum_k G^k \leq \sum_k \sum_i y^{ik} \tau_f^{VI} \tag{1}$$

where G^j is the grant awarded to the government of region j. Denoting by $\bar{y}^{\cdot\cdot}$ the overall average income, (1) boils down to

$$F + \frac{1}{N} \sum_k G^k \leq \bar{y}^{\cdot\cdot} \tau_f^{VI} \tag{2}$$

In the model, each regional median voter chooses the per-capita supply of the local public good of his region. Since the national government follows the demands of subnational entities, each regional median voter also sets the size of the grant. In other words, the grant G^j allocated to region j is the sum of the percapita supplies of the local public good in that region (g^j), i.e. $\sum_i g^j = G^j$. Combining this and (2) we get

$$F + \frac{1}{N} \sum_k N^k g^k \leq \bar{y}^{\cdot\cdot} \tau_f^{VI} \tag{3}$$

Assuming, in line with Peacock and Wiseman's (1961) concept of maximal tolerable size of government, that global government expenditures cannot increase indefinitely, a final constraint is $\sum_k \sum_i F + \sum_k \sum_i g^k \leq \alpha \sum_k \sum_i y^{ij}$ where α ($\in (0,1)$) represents the maximal share of national income that can be devoted to government spending.[6] This expression can be rewritten as

$$F + \frac{1}{N} \sum_k N^k g^k \leq \alpha \bar{y}^{\cdot\cdot} \tag{4}$$

Note that budget constraint (3) is naturally binding (the median voter is a utility maximizer) while this is not necessarily the case for (4) since it could be that the size of the government is smaller than the maximal level tolerated by society.

[6] In some countries, such as Germany, the maximal share of the national income that can be devoted to government expenditures is fixed in the Constitution.

The maximization problem of individual i in region j can be written as

$$\max_{F,\ g^j} \ y^{ij}(1 - \frac{F}{\bar{y}^{\cdot\cdot}} - \frac{1}{\bar{y}^{\cdot\cdot}} \frac{1}{N} \sum_k N^k g^k) + F - C(F) + H(g^j)$$

$$s.t.\ F + \frac{1}{N} \sum_k N^k g^k \leq \alpha \bar{y}^{\cdot\cdot}$$

The first-order conditions yield

$$C'(F_{VI}) = 1 - \frac{y^{ij}}{\bar{y}^{\cdot\cdot}} - \lambda \tag{5}$$

and

$$H'(g^j_{VI}) = \frac{N^j}{N}(\frac{y^{ij}}{\bar{y}^{\cdot\cdot}} + \lambda) \tag{6}$$

where λ is the Lagrange multiplier corresponding to constraint (4).

Turning to the vertical balance case, the allocation of expenditures remains the same as in the previous situation. Nevertheless taxation responsabilities are different: sub-national governments can now levy taxes and do not rely on national government grants to finance their expenditures, i.e. there is complete fiscal responsability.

2.2 Self-financing of sub-national expenditures

Consistently with the vertical imbalance case, utility is assumed to be quasi-linear and composed of disposable income plus an increasing and strictly concave function of the local public good, i.e. $w^{ij} = c^{ij} + H(g^j)$. For individual i in region j in this fiscal setup, the disposable income is now $c^{ij} = y^{ij}(1-\tau_f^{VB}-\tau_s^j)+F-C(F)$ where τ_f^{VB} is the national government's proportional tax rate and τ_s^j is the regional rate. As previously, $F - C(F)$ denotes the net transfers from the national government to individuals. Since there are no longer any grants, the national government's budget constraint simplifies to

$$\frac{F}{\bar{y}^{\cdot\cdot}} \leq \tau_f^{VB} \tag{7}$$

while the government's budget constraint in region j becomes $\sum_i g^j \leq \sum_i y^{ij}\tau_s^j$ or, equivalently

$$\frac{g^j}{\bar{y}^{\cdot j}} \leq \tau_s^j \tag{8}$$

where $\bar{y}^{\cdot j}$ is the average income of region j. The global budget constraint (4) remains unchanged. As previously, budget constraints (7) and (8) are binding, while this is not necessarily the case for (4).

The maximization problem of individual i in region j is now

$$\max_{F,\ g^j} \ y^{ij}(1 - \frac{F}{\bar{y}^{\cdot\cdot}} - \frac{g^j}{\bar{y}^{\cdot j}}) + F - C(F) + H(g^j)$$

subject to budget contraint (4). The first-order conditions of the maximization problem yield

$$C'(F_{VB}) = 1 - \frac{y^{ij}}{\bar{y}^{\cdot\cdot}} - \mu \tag{9}$$

and

$$H'(g^j_{VB}) = \frac{y^{ij}}{\bar{y}^{\cdot j}} + \frac{N^j}{N}\mu \tag{10}$$

where μ is the Lagrange multiplier corresponding to constraint (4).

On the basis of the first order conditions (under both stylized scenarii), it is now possible to discuss all possible cases and identify the solutions that are mathematically pertinent.

2.3 Discussion

In this section, using the first-order conditions, we show that, in case of vertical imbalance and a binding global budget constraint, decentralized entities will ask for a large amount of local public goods and the national government, to fulfill the request will have to reduce its own expenditures (i.e. there will be a substitution of redistributive expenditures for local public goods). On the other hand, in case of vertical imbalance but a non-binding constraint, there will be overspending at the sub-national level but the provision of redistributive expenditures will be the same as in the vertical balance case. These results, summarized by Proposition 1, are obtained through three lemmas.

The first lemma shows that only some values of the Lagrange multipliers μ and λ are mathematically pertinent.

Lemma 1 *$\lambda = 0 = \mu$ or $\lambda > \mu \geq 0$.*

Proof. See Appendix. ■

The proof is by contradiction. Imagine first that relaxing the constraint in the balanced case has a higher effect on the optimal utility of individuals than relaxing it in the unbalanced case (i.e. $\mu > \lambda \geq 0$). Given the strict convexity of the cost associated with redistribution and the strict concavity of the utility function associated with the local public good, this necessarily implies that the size of redistribution and the quantity of local public good provided are larger in the balanced than in the non-balanced case.

Moreover, since $\mu > \lambda \geq 0$, the global budget constraint on the size of government is binding in the balanced case while this is not necessarily the case for the unbalanced one. This is in contradiction with the fact that the size of government, under the initial assumption, must be larger in the balanced case. A similar reasoning can be adopted for excluding $\mu \geq \lambda > 0$.

In Lemma 2, we concentrate on the first of the two possible cases, i.e. $\lambda = 0 = \mu$ and show that in this situation, the provision of local public goods is larger in the unbalanced case than in the balanced case, while redistribution is the same.

Lemma 2 *If $\lambda = 0 = \mu$, then $g^j_{VI} > g^j_{VB}$, and $F_{VI} = F_{VB}$.*

Proof. See Appendix. ■

The proof is straightforward and based on the comparison of the first order conditions of the balanced and unbalanced case. The result is similar to the standard common pool problem: since sub-national entities do not face the entire burden of their expenditures, they have an incentive to overspend. Since $\lambda = 0 = \mu$ leads to a contradiction if the budget constraint is binding, using the same argument as in the proof of Lemma 1, the only possible situation is a non-binding constraint. Hence, national government expenditures are not affected by local overspending.

In Lemma 3, we consider the other possible, i.e. $\lambda > \mu \geq 0$ and show that in this situation, there will be a replacement of redistributive expenditures by local public goods.

Lemma 3 *If $\lambda > \mu \geq 0$, then $g^j_{VI} > g^j_{VB}$, and $F_{VI} < F_{VB}$.*

Proof. See Appendix. ■

The intuition of the proof is the following: we first show that the difference of the effect of relaxing the global constraint in the balanced and unbalanced case is bounded. The lower bound ensures that local expenditures are higher in the unbalanced than in the balanced case. Indeed, since $\lambda > 0$ guarantees that the global constraint with vertical imbalance is binding and $\mu \geq 0$ implies that the constraint is not necessarily binding with vertical balance, there will be a contradiction if local expenditures are lower in the unbalanced case than in the balanced one. The remainder of the proof is based on comparing the first-order conditions for the possible values of λ and μ.

The conclusions of our theoretical model are summarized by the following Proposition:

Proposition 1 *If the global size of the government is not constrained, the provision of local public goods will be larger in case of vertical imbalance than in case of vertical*

balance; redistributive expenditures will be identical in both cases. On the other hand, if the global size of the government is constrained, there will be a substitution of redistributive expenditures by local public goods.

Proof. Straightforward from Lemmas 1, 2, 3. ■

As stated in Proposition 1, the model predicts that, ceteris paribus, vertical imbalance reduces the size of redistributive policies if the global constraint is binding. In the two next sections, we will test if this prediction is confirmed empirically.

3 Empirical test

To test the model, it is important to rely on data that provide information on how public fiscal policies redistribute income through taxation and expenditure. A measure commonly used to quantify universalistic goods (see Milesi-Ferretti et al., 2002 and Persson and Tabellini, 2003) is government monetary transfers to individuals. Such a measure is available for most countries in the world (for a relatively long time span) in the Government Finance Statistics of the IMF. Unfortunately it is not appropriate in this paper for (at least) three reasons. First, redistribution induced by taxation (such as tax progressivity or fiscal cuts) cannot be captured by this measure. Second, it is not possible to see towards which individuals these transfers are directed and therefore it is not possible to guarantee that these transfers are redistributive. Finally, in line with the first point, transfers to households are not the only redistributive tools. Considering education, for example, part of the expenditures, such as the building of schools, do not redistribute income, while others, such as a general public subvention for school fees, do. Our idea to tackle the problem is to quantify the reduction of income inequality induced by taxes and redistribution.[7] In such a way, it will be possible to test the influence of fiscal vertical imbalance on the income redistribution attained through fiscal policies (and thus test the predictions of the model).

The dependent variable in this study, the reduction in inequality induced by fiscal policies, is constructed as follows: first, we compute an inequality index on the basis of market price incomes and another one based on net incomes (after government fiscal intervention). Then, we calculate the decreasing rate of the index while moving from the former to the latter. To the best of our knowledge, the only high quality dataset that can be used for this purpose, as explained in Roland and Verardi (2006), is the Luxembourg

[7] This is done in a similar way as Roland and Verardi (2006).

Income Study (LIS) project database. It covers 29 (OECD) countries[8] and, on average, 4 years for each country. In aggregate, 954 230 individual incomes are available. On the basis of these observations, we construct two inequality indicators: the well-known Gini index (defined as $G = \frac{1}{2n^2\bar{y}} \sum_{i=1}^{n} \sum_{j=1}^{n} |y_i - y_j|$) and the Theil entropy index (defined as $T = \frac{1}{n} \sum_{i=1}^{n} \frac{y_i}{\bar{y}} \ln\left(\frac{y_i}{\bar{y}}\right)$).[9] The former is chosen for its easy interpretation, the latter because, while providing similar information as the Gini index, it fulfills all of the necessary conditions to be considered as a good measure of inequality (see Litchfield, 1999).[10] To measure vertical imbalance, i.e. the degree of dependence of decentralized expenditures on central state financing, we use the classical index provided by the World Bank and computed on the basis of the Government Finance Statistics. It is defined as the ratio of the transfers from the central Government as a percentage of total sub-national expenditures.

The specification of the regression model is simple and of the following type

$$\ln(RI_{it}) = \theta_0 + \theta_1 \ln(VI_{it}) + \bar{\theta}_2 Z_{it} + \theta_3 \ln(I_{m_{it}}) + \varepsilon_{it} \tag{11}$$

where RI_{it} is the rate of reduction of inequality as defined above, VI_{it} is a measure of vertical imbalance, Z_{it} is a set of control variables (and thus $\bar{\theta}_2$ is a vector of coefficients) and $I_{m_{it}}$ is the level of inequality calculated on market prices. Indices i and t respectively represent the country and the year. $I_{m_{it}}$ is considered among the exogenous variables, to correct for the different initial levels of income inequality. In such a way, we identify the effect of decentralization on the reduction of inequality from gross to net incomes, independently of the initial level (or in other words, setting all of the countries at the same market price income inequality). The dependent variable is in logarithm in order to work with elasticities.[11] The estimation method is a two-way fixed effect model[12] to control for all time invarying effects (within country) and country invarying effects (within years). The time varying control variables used are those which are generally accepted to explain inequality. The first two are GDP per capita and GDP per capita squared, since Kuznets (1955) and Lewis (1954) suggest that there should be an inverted

[8] Unfortunately data for control variables are not available for all of them; in our database, we only keep the following 22 countries: Australia, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Hungary, Ireland, Israel, Italy, Luxembourg, Mexico, the Netherlands, Norway, Poland, Spain, Sweden, Switzerland, the United Kingdom, and the United States.

[9] Where y_i represents the income of person i, and $\bar{y}$ represents the average income.

[10] The Gini index, on the other hand, does not satisfy the decomposability property.

[11] Note that RI will never be negative.

[12] Both time and individual.

U relation between development and inequality. The third control variable captures the age structure of the population (percentage of people older than 65) considered because Deaton (1997) argues that inequality should increase with the age of the population, the reason being that young people have more similar incomes than older ones (Deaton and Paxson (1994)). The incorporation in the regression of the fourth control variable (the percentage of people, older than 25, that obtained a higher education diploma) is motivated by Tinbergen (1975) and Li et al. (1998), who suggest that a higher educational attainment is expected to decrease inequality. Taking into account the degree of openness of the country (measured as the logarithm of the sum of exports and imports in percentage of GDP) is aimed at controlling for the link between trade openness and inequality (as implicitly asserted by Rodrik, 1998). It is important to note that we only consider periods and countries for which the level of democracy is high (larger than 0, as measured by Jaggers and Marshall, 2000). Even if the data on income inequality are of a high quality and highly comparable over countries and years, small differences remain between and within countries, but these differences should not affect the results. For example, even if there is a change over time in the survey on which inequalities are calculated in France, Germany and the Netherlands, the definitions of the variables remain the same. Some calculations include net income variables only and some data on taxes are incomplete. To correct for this, we created two dummies identifying each case and included them on the right hand side of the regression. They turn out to be non significative and are thus not included in the final regression. To avoid mixing the effect of decentralization and of vertical imbalance we introduce a measure of the degree of decentralization of the State calculated as the percentage of decentralized expenditures with respect to total expenditures.[13]

The data we use are taken from the Government Finance Statistics of the International Monetary Fund available from the World Bank (with additionnal indicators)[14], the LIS dataset project[15], Persson and Tabellini's (2003) panel dataset[16] and Barro and Lee (2001) education attainment dataset[17].

In Table 1, we present the results of the estimations for both inequality indices. The results are striking: if the vertical imbalance increases by 10%, the reduction in inequality

[13] Results remain unchanged with alternative measures of decentralization such as revenue decentralization.

[14] http://www1.worldbank.org/publicsector/decentralization/Indicators.xls

[15] The access to the dataset is only available for subscribed users.

[16] http://www.igier.uni-bocconi.it/whos.php?vedi=1169&tbn=albero&id_folder=177

[17] http://www.nber.org/pub/barro.lee

induced by government intervention decreases by 2.3 % if we consider the Theil index and 3.6% if we consider the Gini index.[18] Note that the estimated coefficients are not statistically different from each other. This means that the result is not dependent on the index chosen. The goodness of the fit is high since the within R-squared is around 80%. The coefficients associated with the control variables are consistent with previous results.

[INSERT TABLE 1 HERE]

We tested the sensitivity of the results considering two alternatives: (i) allowing for a different definition of the vertical imbalance (i.e. the ratio of decentralized expenditures over decentralized revenues) and (ii) reweighting the data according to the number of individual incomes available for the calculation of inequality indices.[19] As can be seen in Table 2, the results remain unchanged with these modifications.

[INSERT TABLE 2 HERE]

The empirical results confirm the predictions of the theoretical model: high levels of vertical imbalance are associated with lower redistributive policies. This result is not sensitive to different definitions of both income inequality and vertical imbalance. It comes from a within model and represents changes of vertical imbalance and income inequality within countries over time. This means that it is not driven by unobserved heterogeneity between countries.

4 Conclusions

From the literature on decentralization, it appears that the fiscal vertical imbalance is somehow inherent to multi-level governments: while decentralizing expenditures is considered efficient in fitting local preferences and improving the accountability of politicians, decentralizing revenues is generally viewed as dangerous. Tax differentials could lead to a polarization of the economic activity or even to a race to the bottom in taxation inducing an underprovision of public goods. To some extent, this vertical imbalance fosters

[18] We tested for the existence of outliers using least median of squares and no outlier was detected.

[19] The number of available observation on individual incomes that are used to compute the inequality indices are not constant over countries and years.

fiscal indiscipline since it separates spending from revenue responsabilities. The classical effect highlighted in the literature is the famous common pool problem that suggests that sub-national governments will tend to overspend given that they share the burden of their expenditures with the other entities. In this paper, we show that this occurs when the maximal tolerable size of government is not yet reached. Once attained, we explain using a simple model that local entities will continue to overspend and this will induce a reduction in central government expenditures (and more specifically of redistributive expenditures).

The predictions of the model are not easy to test, since government finance statistics do not allow to capture all facets of redistributive policies. For this reason, we decided to tackle the problem indirectly: on the basis of a database on individual incomes, we calculated income inequality before and after taxes and redistribution. If the predictions of our theoretical model are correct, the reduction in inequality should turn out to be inversely related to the degree of vertical imbalance. Our results are conclusive: we find that when the degree of vertical imbalance increases, the effect of redistributive fiscal policies decreases substantially. Regarding the size of the effect, we find that when the degree of dependence of local expenditures on central financing increases by 10%, the effect of redistributive policies on income inequality is reduced by approximately 3%.

APPENDIX

Proof of Lemma 1. Assume first that $\mu > \lambda \geq 0$.

For any i and j, we have that $C'(F_{VB}) = 1 - \frac{y^{ij}}{\bar{y}^{\cdot\cdot}} - \mu$ which, by assumption, is smaller than $C'(F_{VI}) = 1 - \frac{y^{ij}}{\bar{y}^{\cdot\cdot}} - \lambda$. Given that $C(\cdot)$ is assumed to be strictly increasing and strictly convex, we have $F_{VI} > F_{VB}$.

Since $\bar{y}^{\cdot\cdot} = \frac{N^j}{N}\bar{y}^{\cdot j} + \sum_{k \neq j} \frac{N^k}{N}\bar{y}^{\cdot k}$, it is obvious that $\bar{y}^{\cdot\cdot} > \frac{N^j}{N}\bar{y}^{\cdot j}$. Hence, $\lambda \geq \mu + \frac{N}{N^j}\frac{y^{ij}}{\bar{y}^{\cdot j}} - \frac{y^{ij}}{\bar{y}^{\cdot\cdot}}$ is impossible by initial assumption in the proof, then $\lambda < \mu + \frac{N}{N^j}\frac{y^{ij}}{\bar{y}^{\cdot j}} - \frac{y^{ij}}{\bar{y}^{\cdot\cdot}}$. This also means that, for each j, $H'(g^j_{VI}) < H'(g^j_{VB})$. Given that $H(\cdot)$ is assumed to be strictly increasing and strictly concave, we have $g^j_{VI} > g^j_{VB}$.

As $\mu > 0$, the constraint on the global size of the government in the Vertical Balance case is binding, i.e. $F_{VB} + \frac{1}{N}\sum_k N^k g^k_{VB} = \alpha\bar{y}^{\cdot\cdot}$.

As $\lambda \geq 0$, the constraint on the global size of the government in the Vertical Imbalance case is not necessarily binding, i.e. $F_{VI} + \frac{1}{N}\sum_k N^k g^k_{VI} \leq \alpha\bar{y}^{\cdot\cdot}$.

The constraints on the size of the government in both cases along with $F_{VI} > F_{VB}$

and $g^j_{VI} > g^j_{VB}$ imply

$$F_{VB} + \frac{1}{N}\sum_k N^k g^k_{VB} = \alpha\bar{y}^{\cdot\cdot} < F_{VI} + \frac{1}{N}\sum_k N^k g^k_{VI} \leq \alpha\bar{y}^{\cdot\cdot}$$

a contradiction.

A similar proof shows that $\mu \geq \lambda > 0$ is impossible. ■

Proof of Lemma 2. Since $\bar{y}^{\cdot\cdot} = \frac{N^j}{N}\bar{y}^{\cdot j} + \sum_{k\neq j}\frac{N^k}{N}\bar{y}^{\cdot k}$, it is obvious that $\bar{y}^{\cdot\cdot} > \frac{N^j}{N}\bar{y}^{\cdot j}$. Hence, from $\lambda = 0 = \mu$, (10) and (6), we have $H'(g^j_{VB}) > H'(g^j_{VI})$. Given the assumptions on $H(\cdot)$, this implies that $g^j_{VI} > g^j_{VB}$.

Similarly, from $\lambda = 0 = \mu$, (9) and (5), we have $C'(F_{VB}) = 1 - \frac{y^{ij}}{\bar{y}^{\cdot\cdot}}$ and $C'(F_{VI}) = 1 - \frac{y^{ij}}{\bar{y}^{\cdot\cdot}}$ implying that $C'(F_{VB}) = C'(F_{VI})$. Given the assumptions on $C(\cdot)$, this implies that $F_{VB} = F_{VI}$.

When $\lambda = 0 = \mu$, either one or both of the constraints are binding which, as in the proof of Lemma 1, leads to a contradiction, or neither of the constraints is binding and the increase in sub-national expenditures is not accompanied by a decrease in redistributives expenditures ■

Proof of Lemma 3. We first show that if $\lambda > \mu \geq 0$ for any i and j, then necessarily $\lambda < \mu + \frac{N}{N^j}\frac{y^{ij}}{\bar{y}^{\cdot j}} - \frac{y^{ij}}{\bar{y}^{\cdot\cdot}}$.

If not, then, one the one hand, $H'(g^j_{VB}) \leq H'(g^j_{VI})$, which implies $g^j_{VI} \leq g^j_{VB}$ for any j. On the other hand, since $C'(F_{VB}) = 1 - \frac{y^{ij}}{\bar{y}^{\cdot\cdot}} - \mu$ and $C'(F_{VI}) = 1 - \frac{y^{ij}}{\bar{y}^{\cdot\cdot}} - \lambda$, $\lambda > \mu$ implies $C'(F_{VB}) > C'(F_{VI})$. Then, given the initial assumptions on $C(\cdot)$, we have $F_{VB} > F_{VI}$.

As $\mu \geq 0$, the constraint on the global size of the government in the vertical balance case is not necessary binding, i.e. $F_{VB} + \frac{1}{N}\sum_k N^k g^k_{VB} \leq \alpha\bar{y}^{\cdot\cdot}$.

As $\lambda > 0$, the constraint on the global size of the government in the vertical imbalance case is binding, i.e. $F_{VI} + \frac{1}{N}\sum_k N^k g^k_{VI} = \alpha\bar{y}^{\cdot\cdot}$.

The constraints on the size of the government in both cases along with $F_{VI} < F_{VB}$, , and $g^j_{VI} \leq g^j_{VB}$ imply

$$F_{VI} + \frac{1}{N}\sum_k N^k g^k_{VI} = \alpha\bar{y}^{\cdot\cdot} < F_{VB} + \frac{1}{N}\sum_k N^k g^k_{VB} \leq \alpha\bar{y}^{\cdot\cdot}$$

a contradiction.

As a result, recalling that $H'(g^j_{VB}) = \frac{y^{ij}}{\bar{y}^{\cdot j}} + \frac{N^j}{N}\mu$ and $H'(g^j_{VI}) = \frac{N^j}{N}(\frac{y^{ij}}{\bar{y}^{\cdot\cdot}} + \lambda)$, from $\lambda < \mu + \frac{N}{N^j}\frac{y^{ij}}{\bar{y}^{\cdot j}} - \frac{y^{ij}}{\bar{y}^{\cdot\cdot}}$, we get $H'(g^j_{VB}) > H'(g^j_{VI})$ implying $g^j_{VB} < g^j_{VI}$. Finally, from $\lambda > \mu$, we obtain $C'(F_{VB}) > C'(F_{VI})$ implying $F_{VB} > F_{VI}$. ■

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Table 1: Reduction in Inequality and Vertical Imbalance

	Theil	Gini
ln(VIM)	-0.23^{***}	-0.36^{***}
	(2.49)	(2.87)
ln(Inequality)	0.15^{**}	0.86^{**}
	(2.61)	(2.24)
Decentralization	-0.01	-0.01
	(1.39)	(1.47)
Higher Education	-0.01^{**}	-0.01^{***}
	(2.52)	(3.56)
ln(Openness)	0.06	0.22
	(0.55)	(1.53)
Elderly	0.24	-0.30
	(0.09)	(0.09)
GDP per Capita	0.00	0.00
	(0.54)	(0.79)
GDP per Capita Squared	-0.00	-0.00
	(0.42)	(0.59)
Constant	4.41^{***}	4.43^{***}
	(3.63)	(2.86)
Individuals	954230	954230
Aggregate Indicators	72	72
Countries	22	22
R-squared	0.79	0.82

Robust absolute t statistics in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 2: Sensitivity Analysis

	Theil	Gini	Theil (w)	Gini (w)
ln(VIM)	-0.23^{**}	-0.36^{***}	-0.25^{**}	-0.35^{**}
	(2.49)	(2.87)	(2.59)	(2.68)
ln(VIMbis)	-0.17^{***}	-0.25^{***}	-0.16^{**}	-0.22^{**}
	(2.90)	(3.42)	(2.16)	(2.47)

Robust absolute t statistics in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%