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This study examines the relationship between fiscal decentralization and the functional composition of public expenditures. We empirically test this hypothesis using an unbalanced panel data set of 45 developed and developing countries covering a 28-year period. We find strong evidence that fiscal decentralization increases the share of education and health expenditures in total government expenditures in developing and industrialized countries. We also note that the influence of decentralization on the composition of public expenditures may be greater in developing countries relative to industrialized countries.

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Abstract

This study examines the relationship between fiscal decentralization and the functional composition of public expenditures. Using a distance-sensitive representative agent model, we hypothesize that higher levels of fiscal decentralization induce agents to demand increased production of publicly provided private goods. We empirically test this hypothesis using an unbalanced panel data set of 45 developed and developing countries covering a 28-year period. We find strong evidence that fiscal decentralization increases the share of education and health expenditures in total government expenditures in developing and industrialized countries. We also note that the influence of decentralization on the composition of public expenditures may be greater in developing countries relative to industrialized countries.

Keywords: Fiscal Decentralization, Functional Composition, Pure Public Goods, Publicly Provided Private Goods, Education, Health

JEL classification: H30, H50

1. Introduction

The application of fiscal decentralization reforms and demand for fiscal decentralization policy design has grown significantly in developed and developing countries in the past two decades.[1] This wave of decentralization reforms is driven by diverse economic and political factors, from the pursuit of increased economic efficiency to the expansion of democratic governance (Shah and Thompson, 2002; Arzaghi and Henderson 2005). Despite being at the forefront of policy discussion of poor and rich countries alike, the empirical analysis of the impact of fiscal decentralization reforms is fairly new and our knowledge of many of these issues remains limited.[2]

Researchers and policymakers alike have promoted decentralization reform agendas on the premise that decentralization results in a more efficient allocation of public goods by enabling local governments, which have better information, to tailor more closely their public spending decisions to the needs and preferences of their constituencies. While there is a significant body of work on the theoretical underpinnings of the efficiency effects of fiscal decentralization (Oates, 1972; Mas-Colell, 1980), or more generally, of allocative efficiency under the analytical framework of effective federalism (Rubinfeld, 1987), there is a relative paucity of empirical evidence on this subject.

Empirical research on the hypothesized impact of decentralization on allocative efficiency has been handicapped by the complexity of generating standardized measurements of allocative efficiency across countries. However, implicit in the argument that decentralization can increase allocative efficiency, is the implication that decentralization is likely to alter the

[1] For reviews of the literature on the emergence of decentralization, see Shah (1994), Boadway et al. (1994), Dillinger (1994), Bird, Ebel, and Wallich (1995), Manor (1994), Campbell (2003), Martinez-Vazquez and McNab (2003) and Oates (2004).
[2] See, for example, Shah (1997) and Martinez-Vazquez and McNab (2003).

composition of public expenditures. By comparison to using direct measures of allocative efficiency, examining the relationship between fiscal decentralization and composition of public expenditures is relatively straightforward.

Several recent papers have examined the determinants of the composition of public expenditures (among others, Barro 1990, Devarajan and Swaroop, and Zou, 1996; and Sanz and Velasquez, 2004). While this literature offers considerable insight on the composition of public expenditures, none of these studies has examined explicitly the potential influence of fiscal decentralization on expenditure composition and its link to allocative efficiency. What evidence does exist on the role of decentralization is limited to country-specific analysis.[3]

The main goal of this paper is to offer an indirect test of the allocative efficiency effects of decentralization by examining the role of decentralization on the composition of public expenditures. First, we explore the theoretical linkages between decentralized governance and expenditure composition by means of a distance-sensitive representative agent model. Then we estimate the impact of fiscal decentralization on the level and functional composition of public expenditures using an unbalanced panel data set spanning 45 developed and developing economies over a period of 28 years.[4]

The remainder of the paper is organized as follows. Section two presents a review of the previous literature. Section three develops the theoretical model. Section four discusses the data and presents the estimation results. Section five concludes.

[3] See Faguet (2000), for a case study of the impact of decentralization on expenditure composition in Bolivia.

[4] Our analysis focuses on the functional classification of public expenditures as opposed to economic or other types of classifications. The intergovernmental reform discourse tends to be overwhelmingly about the assignment of health, education, and other functional spending assignments, as opposed to how wage expenditures and the like should be distributed among different levels of government.

2. Review of the Literature

Over the past decade a number of scholars and practitioners have examined the relationship between the composition of public expenditures and a variety of macroeconomic variables, including welfare and human capital, income inequality, macroeconomic stability, fiscal competition, and economic growth.[5] Devarajan, Swaroop, and Zou (1996) and Sanz and Velázquez (2004) provide two good examples of this literature. Examining the influence of expenditure composition on economic growth in developing countries, Devarajan et al. (1996) find that defense expenditures and infrastructure investments appear to negatively influence economic growth. Contemporaneous consumption-oriented public expenditures, on the other hand, appear to positively influence economic growth, suggesting that the developing countries in the sample could increase economic growth by reallocating resources from military and infrastructure expenditures to consumption-oriented expenditures.[6] Sanz and Velázquez (2004) employ an augmented median voter model to study the determinants of expenditure composition at one single level of government in a panel of OECD countries. They find that income, private-public relative prices, institutional factors, and demographics significantly affect public expenditure composition. Another interesting recent study from the International Monetary Fund (IMF, 2003) examines the impact of economic crises and fiscal deficits on social expenditures and social protection programs. This study finds that IMF supported programs, which are typically implemented as a result of external shocks, do not adversely impact education and health expenditures.[7]

[5] See, among others, Aschauer (1989, 1990), Turnovsky and Fisher (1995), Matovu (2000), and Gupta, Clements, Baldacci, and Mulas-Granados, 2002).
[6] However, the coefficients for health and education expenditures in this study are statistically insignificant.
[7] Snyder and Yackovlev (2000) argue that education and health expenditures are pro-cyclical in Latin America and counter-cyclical in the United States.

But note that none of the above studies address the impact of fiscal decentralization on the composition of public expenditures. Faguet (2004), who examined the influence of fiscal decentralization on expenditure composition in Bolivia from 1991 to 1996, is the exception in the literature. Faguet finds evidence that fiscal decentralization increases investment in socially-oriented sectors, such as education, urban development, water and sanitation, and health care.[8]

While Faguet's results are suggestive of a relationship between fiscal decentralization and the functional composition of public expenditures, two tasks remain to be done. First, is to show that these results can be generalized and that they are not a reflection of a unique experience of a specific country. Second, is to develop a theoretical model to explain the channels through which fiscal decentralization may influence the composition of public expenditures. We endeavor to address these gaps in the literature in the following sections.

3. Modeling the Relationship between Decentralization and Expenditure Composition

The model developed in this section stresses the heterogeneous nature of tastes among jurisdictions as a fundamental factor of the relationship between fiscal decentralization and the composition of public expenditures. A main objective of the model is to account for the heterogeneity of individual preferences across local jurisdictions within a theoretical framework that focuses only on a "representative" median-voter. The heterogeneity of individual preferences has been largely ignored in representative-agent models and the application of this type of models to decentralization issues has drawn criticism in the literature.[9]

[8] This pattern of decentralized expenditures concentrated on the provision of services related to poverty alleviation had been anticipated in the fiscal decentralization literature. See, among others, Fox and Aranda, (1996) and Bird and Vaillancourt (1998).

[9] Fundamentally, decentralization would not make much sense if we assume that all individuals have identical preferences as it is often assumed in representative-agent models. See Kirman (1992) and Martinez-Vazquez and McNab (2003).

Here we employ a distance-sensitive utility function which allows us to assume that all individuals have the same general utility but "each one of them" has a different preferred type of public good and also demands a different quantity of it. Our modeling of heterogeneous preferences is further based on two additional assumptions: a) individuals are uniformly distributed along a country area, and b) individual utility accrued from any given public good is decreasing on distance to the middle of the country or jurisdiction that provides it.[10]

Previous work by Alesina and Spolaore (1996), Alesina, Baquir, and Easterly (1996), and Panizza (1999) employed distance-sensitive utility functions with one public and one private good. In our model we extend the distance-sensitive representative agent model to an economy with two levels of government and two types of publicly provided goods.[11]

In short, the model explicitly provides a link between the representative agent's utility and the composition of national and subnational public expenditures. To get there we extend Alesina, Baquir, and Easterly's (1996) result that the optimal amount of publicly provided goods is a function of the "median distance from the median" from a uni-dimensional to a multi-dimensional voting model.

We assume that individuals are uniformly distributed along a country with area A, population N, and J municipalities (where $J > 1$). Each agent consumes three types of goods: one private good (C) and two publicly provided goods: S, a Samuelsonian pure public good (PPG) provided solely by the central government and G, a publicly provided private good ($PPPG$) whose provision is divided between the central government and local governments. Per capita consumption of these goods is represented by c, s, and g, respectively. We assume an exogenous level of centralization (θ) which is equal to the fraction of the PPPG provided by the

[10] Below we elaborate further on the assumption of a uniform distribution of individuals.

[11] For space reasons we present only a stylized version of the model. The complete derivation of the model is available from the authors upon request.

central government.[12] Education and national defense are examples of a PPPG and a PPG, respectively.[13]

We assume that each individual has a set of characteristics that determine their preferred type and quantity of the PPG and PPPG.[14] The type and quantity of each public good are decided democratically by the median voter (med^s, med^g). For this reason, it is possible that there may exist a separate "type median voter" and "quantity median voter" for each public good. In order to ensure the median voter result given multidimensional voting, we must assume that: a) individuals vote on one issue at a time and b) individuals have separable preferences.[15]

We further assume that individuals are uniformly distributed, Tiebout-sorted, and pay a lump sum tax t on the same income y.[16] Each type of PPG is located on an ideological Euclidean space that captures individual preferences and represents the area of the country.[17] We assume that voter's optima are evenly distributed over the space, that the number of voters is great enough so that the space can serve as a proxy for the voters, and the country size area is

[12] We do not derive an optimal level of centralization. This would require the specification of a government objective function and the determinants of fiscal decentralization. See Panizza (1999).

[13] There may disagreement with the choice of these two examples; we base our choice of education as a PPPG on previous studies that have shown education services subject to considerable "crowding."

[14] We must differentiate between the two kinds of publicly provided goods and the many types of each good that can be provided. Education is a publicly provided good, which can be clearly categorized into different types based on the characteristics of the educational curriculum of schools. Some educational programs may impart certain religious beliefs and practices while others may be mainly focused on the development of the musical abilities of the students. Alesina, Baqir and Easterly (1996) present a model on which each jurisdiction decides on the type and quantity of a unique public good, the only difference here is that we assume the existence of more than one public good.

[15] Assumptions *a* and *b* are introduced to avoid issues of simultaneous multidimensional voting. Enelow and Hinich (1984) prove that, under these assumptions, the outcome of majority voting is the optimum alternative of the median voter on each issue. We do not consider any distortions to the democratic process in this model. See Bardhan and Mookherjee (2000) for a theoretical model on capture of the democratic process at the local and national level and Panizza (1999) for discussion on the extent that a democratic system is offset by Leviathan local and central governments.

[16] Income distribution issues are assumed away, not because they are considered unimportant, but in order to isolate the locational efficiency effects of decentralized decision-making (Wildasin 1991, 1994).

[17] This is an extension of Alesina and Spalaore (1996) to a multidimensional problem. See Enelow and Hinich (1984) for further discussion of multidimensional voting.

normalized at one with no loss of generality.[18] The distribution of individuals is such that each alternative can be uniquely mapped in the Euclidean Space.

Based upon these assumptions, individual *i*'s utility function is given by:

$$U_i = s_i^{\,1-\alpha y_{ic}}\, g_i^{(1-\alpha(\theta x_{ic}+(1-\theta)x_{ij}))} c_i^{\,\beta} \tag{1}$$

where *s, g, c*, and θ are as defined previously; y_{ic} is individual *i's* distance to the middle of the country measured on the PPG axis*;* x_{ic} is individual *i's* distance to the middle of the country measured on the PPPG axis; and x_{ij} is individual *i's* distance to the middle of the jurisdiction where he resides measured over the PPPG axis. The parameter α, where $0 \leq \alpha \leq 1$, measures preference heterogeneity, that is as α approaches 0, preferences become relatively more homogenous.

The public budget constraint is $T = G + S$, where T represents general (central plus subnational) tax revenue and p_g and p_s are normalized to one.[19] The representative agent's budget constraint before taxes is $y = s + g + c$ or $y = c + t$. Let $\delta_i = 1 - \alpha(\theta x_{ic} + (1-\theta) x_{ij})$ and $\gamma_i = 1 - \alpha y_{ic}$, then the maximization of the individual's utility function with respect to the budget constraint generates the following demand functions:

$$g_i = \frac{\delta_i y}{\delta_i + \gamma_i + \beta};\ s_i = \frac{\gamma_i\, y}{\delta_i + \gamma_i + \beta};\ \ c_i = \frac{\beta\, y}{\delta_i + \gamma_i + \beta} \tag{2}$$

We can employ the Euclidean distance between two points to measure each individual's distance between their preferred types of PPPGs and those actually provided. Let $\| z - z^m \| = c$

[18] These assumptions have been used on several other studies that use a Euclidean space as an analytical tool for spatial analysis (Tullock, 1967; Plott, 1967; Davis, DeGroot, and Hinich, 1971).

[19] It is important to note that this model is based on the maximization of individual utility by finding the optimal demand for public goods. For this maximization problem the relevant constraint is individual after tax income. Individual after tax income is independent of the level of government providing the good and of the location of the individual. This independence is guaranteed because all public goods in this model are financed through an income lump sump tax and because the assumption that all individuals have equal income. Also note that we do not include any assumptions related to the production of public goods, such as costs differentials, or shared tax sources between levels of government. See, among others, Nechyba (1997), Wrede (2000), and Caplan (2001), Faguet (2003).

be part of a circle on which each point $z = (y_1, x_1)$ has a constant Euclidean distance to the point at which the type-median is located $z^m = (y_m, x_m)$. As illustrated in Figure 1, for each individual located on the circle, there exists another individual with exactly the same horizontal and vertical distance to the center of the circle. Individuals with same horizontal and vertical distances to the type-median will demand the same quantity of each good.[20]

Given symmetric preferences, the quantity median voter is located at a distance equal to the 'median distance to the median' along the horizontal axis. For a country with area A, the median distance to the median is Ax/4. Let $\delta_k = 1 - \alpha(\theta x^m_{kc} + (1-\theta) x^m_{kj}) > 0$ and $\gamma_k = 1 - \alpha y_{kc} > 0$, y^m_{kc} be the median distance to PPG type-median, x^m_{kc} be the median distance to the PPPG country type-median, and x^m_{kj} be the median distance to the PPPG jurisdiction type-median. Using (2) we can express the quantities of g and s provided at equilibrium as:

$$g^*_k = \frac{\delta_k y}{\delta_k + \gamma_k + \beta}; \quad s^*_k = \frac{\gamma_k y}{\delta_k + \gamma_k + \beta} \tag{3}$$

From (2) and (3), we develop four propositions which are tested empirically in the following section. We summarize the decision-making mechanism for both type and quantity of both types of public goods in Appendix 1 and present, where applicable, the proofs of the propositions in Appendix 2.

Propositions on Centralization and the Composition of Public Expenditure

Given heterogeneous preferences, as the centralization level increases, the number of dissatisfied individuals with respect to the PPPG's type increases accordingly. All else being equal, demand for PPPG expenditure is inversely related to the level of centralization.

[20] This is as opposed to individuals with same Euclidean distance to type median, who will not all demand the same quantity of public goods. In Figure 1 all points in the circle have the same Euclidean distance to the middle. However, just the pairs of points situated exactly in opposite sides of the circle have same horizontal and vertical distances to the middle.

Conversely, demand for PPG expenditure is positively related to the level of centralization as individuals substitute away from PPPGs towards the centrally provided PPG. The following propositions summarize these results.

Proposition 1:PPPG equilibrium quantity is decreasing in the centralization level, that is, $\delta g^*_k / \delta\theta < 0$.

Proposition 2:PPG equilibrium quantity is increasing in the centralization level, that is, $\delta s^*_k / \delta\theta > 0$.

The intuition of Proposition 1 is simple. In a more centralized country there will be more unhappy individuals with the chosen PPPG's type. As a result, overall demand and support for this kind of expenditure will be smaller, other things equal, than in a more decentralized country. Given that PPGs are provided centrally, the quantity of each PPG will be decided by the country's median voter. The median voter's decision on the provision of the PPG is inversely related to the median distance to the country median. Likewise, a share of PPPG expenditure is provided by local governments and the quantity of each PPPG is decided by the median voter of each jurisdiction. This decision is inversely related to the median distance to the jurisdiction median. If more than one jurisdiction exists, the median distance to the country median is greater than the median distance to the jurisdiction median. Thus, the more decentralized the provision of public goods, the higher the demand for PPPGs relative to PPGs. As the level of decentralization increases, the provision of PPGs declines at a faster rate than the PPPGs increase, thus, the total level of public expenditure also declines. Intuitively, decentralized provision of public goods allows local governments to provide combinations of goods to each jurisdiction, as opposed to provide a whole package to all jurisdictions in the country like the

central government may be forced to do (due to lack of knowledge on local preferences or other constraints).[21] The following propositions summarize these results.

Proposition 3:PPPG share of total expenditure is decreasing in the centralization level, that is, $\delta(g/(g+s))/\delta\theta < 0$.

Proposition 4:Total public expenditure is increasing in the centralization level, that is, $\delta(g+s)/\delta\theta > 0$.

The interpretation of these results is again quite straightforward. First, the central government chooses the level of centralization for public good provision (exogenous in this model). Second, if the provision of the public good is centralized, the "type" will be decided by the preferences the overall median voter. If, in contrast, the public good is provided by each jurisdiction, the "type" will be decided by the type-median voter of each locality. Once the type of each kind of public good is decided, individuals decide the quantity to be provided. Individuals demand more publicly provided goods the closer the type is to their individual preferences.

Given the fact that pure public goods in our model are provided centrally, the quantity of such goods will be decided by the overall median voter. This decision is inversely related to the 'median distance to the country median'. Conversely, a share of the PPPG expenditures in our model is provided by the local government. The quantity of PPPG is decided by the jurisdiction median voter. This decision is inversely related to the median distance to the jurisdiction median. In countries with more than just one jurisdiction, the median distance to the country median is higher than 'the median distance to the jurisdiction median'. This determines that the more decentralized is the provision of public goods the higher the demand for publicly provided

[21] Note that it may be possible got the central government to provide different packages of PPPGs to different jurisdictions. For example, Lockwood (2002) and Besley and Coate (2003) present models where the central authorities are able to discriminate among jurisdictions with different packages of services. In this paper we keep the conventional assumption that central provision is homogenous for all jurisdictions.

private goods as opposed to pure public goods. In other words, given the distribution of preferences, the more centralized the provision of goods the lower the ratio of publicly provided private goods to total amount of public goods provided. [22]

Intuitively, Proposition 4 suggests that decentralized provision of public goods allows local government to provide specifics goods or combinations of goods to each jurisdiction as opposed to the need of providing a whole package to all jurisdictions in the country, as the central government may be forced to do due to lack of knowledge on local preferences or otherwise (political) inability to discriminate among jurisdictions.[23] This specialization of public good provision implies a potentially lower level of total expenditures. Proposition 4 is also in line with several hypothesis in the decentralization literature. Alternative explanations include: a) decentralization can lead to lower expenditures due a reduction in redistribution expenditures due to Tiebout sorting, which would imply income-homogeneous jurisdictions; this is an argument originally made by Musgrave (Oates, 1985); or b) decentralization constitutes a disciplining force that provides a closer link between revenues and spending, as in Brennan and Buchanan's Leviathan Hypothesis (1980). What is novel in our result in Proposition 4 is that the shrinking effect of decentralization on overall public expenditures does not depend on fiscal competition, as in Brennan and Buchanan, or on the reduction of redistributional expenditures as noted by Musgrave. However, our results presupposes some sort of Tiebout sorting and the inability of the central government to offer different packages, or discriminate, across local jurisdictions.

4. Empirical Analysis

We now turn to examining whether empirical support exists for our theoretical model. In this section we focus on testing the empirical validity of Proposition 3 on the relationship

[22] Given our assumption of the spatial distribution of individuals on the country and the correspondence of location and preferences.
[23] But see footnote 21 above.

between decentralization and expenditure composition.[24] As in the case of several more recent studies of the relationship between fiscal decentralization and economic growth, we employ a panel data set of developed and developing countries.[25]

The Data

One common difficulty faced in the cross-country study of fiscal decentralization is how to properly measure the extent of decentralization. Ideally, we would construct a panel data set of measures of fiscal decentralization that effectively quantified the activities of subnational governments resulting from their autonomous or independent decisions. This would require classifying those expenditures that are under the effective control of the central government as central government activities, regardless of the level of government at which these expenditures occurred. Likewise, activities that were under the control of subnational governments, even if they were funded by the central government, would be classified as subnational government activities. Constructing such a panel data set of measures of the decentralization of expenditures would require information on the overall level of political, administrative and fiscal autonomy of subnational governments (Martinez-Vazquez and McNab 2003). Unfortunately, we cannot readily address these issues with the available data. We are, as Oates (1972) concluded, left with the standard, albeit imperfect, measure of fiscal decentralization based on expenditure data. We define fiscal decentralization as the share of subnational government expenditures to general government expenditures.[26] We employ the International Monetary Fund's Government Finance

[24] Testing the effects of decentralization on the equilibrium quantities of PPPG and PPG in Propositions 1 and 2 will involve very different data sets and will be perform in future research. On the other hand, the equivalent of Proposition 4 has been tested in many different occasions in the empirical public finance literature, especially in the case of the Leviathan model, with mixed results. See, for example, Oates (1985, 1989).

[25] See Davoodi and Zou (1998) and Woller and Phillips (1998), and Treisman (2000). See also Hsiao (1986) and Baltagi (1995) for a discussion of the advantages and problems associated with the use of panel data.

[26] See Bird (2000) and Ebel and Yilmaz (2002) for a discussion of the pitfalls associated with the conventional measurement of fiscal decentralization. The OECD dataset suggested by Ebel & Yilmaz, however, includes only data for six countries on a period of only three years (1997-1999). While some studies of fiscal decentralization

Statistics Annual Yearbook (GFS) as the primary data source for expenditures of national and subnational governments.[27]

Combining the GFS data with the data extracted from the other data sources reduced the size of the data set from approximately 1,000 observations to approximately 600 observations due to missing observations for some control variables in the World Development Indicators 2002 dataset. The final panel dataset covers 45 countries from 1973-2000. Table 1 defines the variables used in the empirical model and their sources. Table 2 presents descriptive statistics of these variables. The control variables used in the econometric model are discussed below.

To test the propositions developed in the preceeding section, we need to classify observed public expenditures as either coming from pure public goods or from publicly provided private goods. We simplify this task by focusing on the identification of two public services as publicly provided private goods: education and health. Together these two services tend to represent a large share of decentralized expenditures in most countries. A standard technique to identify the degree of publicness of government services, used in studies related to the determinants of public expenditures and the demand for public goods, is the calculation of a crowding parameter.[28] Borcherding and Deacon (1972), Oxley and Martin (1991), and Saunders (1993) have all argued that health and education expenditures should be classified as publicly provided private goods, subject to specific caveats on the measurement of the crowding parameter.

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have attempted to construct measures of decentralization net of grants and transfers and net of certain types of expenditures, we do not construct such measures, as we are not able to ascertain, with any degree of certainty, whether these techniques reduce or enhance the bias already present in our measures of fiscal decentralization. See, for example, Woller and Phillips (1998) and Lin and Liu (2000).

[27] We use GFS data at the consolidated central government, regional and state government, and local government levels. For those countries that do not report consolidated central government data, we substitute data on the budgetary central government. Of the 180-plus potential countries in the GFS data set, we selected countries that reported expenditures for at least the central government and at least one level of subnational government. We did not include those countries that stopped reporting expenditure information prior to 1990 and those countries whose reported data were mathematically inconsistent. We did include countries that reported zero or minimal expenditures for at least one subnational level of government.

[28] See, for example, Borcherding and Deacon (1972), Gramlich and Rubinfeld (1982), Martinez-Vazquez (1982), or Blecha (1987).

While we cannot provide empirical evidence at this juncture on the degree of crowding for education and health services in the sample countries, we believe that is relatively safe to assume that these two types of services generally do not exhibit the characteristics of non-excludability and non-rivalry of pure public goods. Burki, Perry, and Dillinger (1999), for example, note that immunization, sanitation, other public health services are non-exclusive but rival; while services of acute health care are clearly rival and exclusive. Similarly, classroom size limitations and number of teachers per student in most of the developing countries clearly add some degree of rivalry to education services.

Model Specification and Econometric Issues

We now turn to the empirical examination of the theoretical propositions developed in the previous section. The dependent variable, *Comp*, is defined as the ratio of education and health expenditures to total public expenditures. Thus, the empirical statement of Proposition 3 in the previous section, is that, all other things equal, more decentralized countries spend a higher share of their expenditures on education and health. In terms of the explanatory variables in the model, our main interest is on decentralization, *Dec*, which is measured as the share of subnational expenditures in total public expenditures. A matrix *X* of control variables, includes population, population density, GDP per capita, and budget balance. We allow for potential differences in the impact of decentralization on expenditure composition in developing and developed countries by introducing an interaction term, *dev*, between our decentalization measure and a dummy variable to capture industralized country status. We can specify the general estimation form as:

$$Comp_{i,t} = G(\alpha_0 + \alpha_1 Dec_{i,t} + \alpha_2 X_{i,t} + \alpha_3 dev_i + a_i + u_{i,t}), \qquad (4)$$

where $G(\cdot)$ is a transformation function we apply due to the fractional nature of the dependent variable (discussed below), and where a_i denotes the unobserved country effect.[29] The subscripts i and t denote country and time period, respectively.

The general estimable form in (4) precludes the use of several time-invariant variables that have been previously used in the literature, if a fixed effects estimation is employed. Variables such as ethnic fractionalization, country size, colonial tradition, legal tradition, and religious dominance are all 'swept' by the Within transformation of the fixed effects estimator.[30]

The transformation function $G(\cdot)$ in (4) is implemented because the dependent variable is a fractional variable constrained on the unit interval [0,1] and it may not offer sufficient variation for estimation by OLS (Papke and Wooldridge, 1996). Interpretation problems may arise as there is no guarantee that the predicted value of the dependent variable lies on the unit interval, so the estimated coefficients may account for more than can be rationally interpreted. Typically the literature had dealt with this issue with a logistic transformation, however, Papke and Wooldridge note that there are computation limitations on obtaining the true predicted value from the logistic transformation and suggest the use of a quasi-maxmimum likelihood estimator

[29] The unobserved effects can be thought of as omitted variables that are constant within a group. Equation (4) is also referred as a one-way error component model, because it does no include a time specific effect γ_t, often used in panel data models (two-way error component models). We do not explicitly include the time specific effect variable in the model for simplicity. However, since the number of periods is fairly small we remedy this by adding a set of time specific dummy variables to all the models.

[30] We were unable to collect panel data for many countries on population age structure. This variable is used, for example, by Sanz and Velázquez (2004). We are not certain of what effects that may have in our estimates, but for example Poterba, (1996) and Fernandez, and Rogerson (1997) find no or little effect of population age structure on education spending. In addition, we are able to control for corruption, which may have an impact also on expenditure composition (Mauro, 1998). In this case the problem has to do with the nature of available data on corruption. For example, in the case of Transparency International (2004) Corruption Perceptions Index, year-to-year changes in a country's score result can be simply due a changing sample and methodology rather than the underlying corruption. This same problem is also addressed by Kaufmann, Kraay, and Mastruzzi (2005) for other corruption measures. An alternative choice for us would have been to modify our estimation approach from panel to cross-sectional analysis. We decided against it because of the significant loss in degrees of freedom. We should note that the level of country corruption is captured, especially to the extent that corruption does not change significantly over time, by the fixed effect component of our model.

(QMLE) to guaruntee that the predicted values of the dependent variable lie on the unit interval.[31]

As our sample period spans 27 years, we suspect *a priori* that serial correlation may be a problem.[32] In order to test for serial correlation we employed the modified Durbin Watson Statistic based on the within residuals rather than the OLS residuals, as suggested by Bhargava, Franzini, and Narendranathan (1982).[33]

In what follows we present five alternative econometric models to estimate the general specification in equation (4), which allows us to test for the robustness of our results concerning the impact of decentralization on expenditure composition. The first model employs an OLS estimator and first differenced data. The second and third models employ the Cochrane-Orcutt (1949) transformation for unbalanced panel data (Baltagi 1995), and differ only in the use of the within or random effects GLS estimator.[34] The fourth model is the QMLE suggested by Papke and Wooldridge, with fixed country and time specific effects. The fifth model is a least-squares dummy variable model. We correct the standard errors in all the estimated models through the use of the White (1980) variance-covarariance matrix estimator. Table 3 summarizes the econometric approches used on each of the five models estimated.

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[31] As the QMLE estimation is based on the maximization of a Bernoulli log likelihood function on the basis of the distribution of $E(y|x) = G(x\beta)$, where G is the logistic transform that satisfies $0 < G < 1$, the predicted values are guaranteed to lie on the unit interval.

[32] See Table A2 in the Appendix section for a summary of countries and years covered.

[33] See also Baltagi (1995). For the two-way fixed effects error components estimation, the estimated Durbin-Watson statistic is 0.73 with an estimated autoregressive parameter of 0.79.

[34] Models 2 and 3 are based on the linear regression of the transformed model: $\ddot{y}_{i,t} = \alpha + \beta\, \ddot{x} + u_{i,t}$, where $\ddot{y}_{i,t} = y_{it} - \theta\, \bar{y}$, $\ddot{x}_{i,t} = x_{i,t} - \theta\, \bar{x}$. For the fixed effects model, $\theta = 1$, this transforms the data to variations of the mean over time *within* each cross sectional group. For the Random effects, $\hat{\theta} = 1 - \{1/[1 + T(\hat{\sigma}^2{}_a / \hat{\sigma}^2{}_u)]\}^{1/2}$, where $\hat{\sigma}^2{}_a$ and $\hat{\sigma}^2{}_u$ are estimators of $\sigma^2{}_a$ and $\sigma^2{}_u$ based on the pooled OLS or the fixed effects residuals. After the C-O transformation: $\ddot{y}_{i,t} - \hat{\rho}\ddot{y}_{i,t-1} = \alpha(1-\hat{\rho}) + \beta(\ddot{X}_{i,t} - \hat{\rho}\ddot{X}_{i,t-1}) + \ddot{\eta}_{i,t}$, where the autocorrelation parameter comes from $\ddot{\varepsilon}_{i,t} = \rho\ddot{\varepsilon}_{i,t-1} + \ddot{\eta}_{i,t}$.

The fourth model using QMLE requires a bit more explanation. Here we control for serial correlation by correcting the estimated variance-covariance matrix as opposed to transforming the data through first differencing or a Cochrane-Orcutt transformation. Using the variance-covariance matrix is desirable for us because we are interested in examining a proposition in levels while the first differencing transformation would have changed the question under consideration to one of change-on-change. With respect to the fixed effects, the literature supports the argument that fully robust estimators work reasonably well even when the cross-sectional sample size is not especially large relative to the time series dimension (Wooldridge 2002, 2003). Given the relatively small number of groups in our sample (N=45), the inconvenience of using a set of country dummies in order to control for unobserved country effects is not as great compared to the existing alternatives.[35]

We must also note that the QMLE marginal effects are non-linear functions of the estimated coefficients and the specific values of the explanatory variables. Given the logistic density function $g(z) = \delta G(z) / \delta z = exp(z)/(1+exp(z)]^2$, the QMLE marginal effects are equal to $\delta E(y|x)/\delta x_j = m_j = g(x\beta)\beta_j$. We can calculate the marginal effects using the mean values of the explanatory variables where the linear prediction is $\bar{x}\hat{\beta}$ = -1.1845, and the density for the logistic distribution is $g(\bar{x}\hat{\beta}) = .1794$.

Returning now to all five estimating models, we use Likelihood Ratio and F tests to examine if the country and time-specific effects are jointly equal to zero and in all cases we are unable to reject the null hypothesis that the effects are jointly equal to zero. We thus include

[35] In contrast to the within and random estimation methods for linear models, the literature on fixed and random effects for nonlinear models is limited. One theoretical approach to control for unobserved effects in nonlinear models is to maximize a conditional likelihood, for which the unobserved effects are integrated out. This is done through a conditional joint distribution (Hausman, Griliches, and Hall, 1993; Greene, 2001, 2002; Wooldridge, 2002). But despite these computational advances, in most models it is not always possible to remove the unobserved effects from the density, especially in estimations with continuous dependent variables.

country and time specific effects in each of the estimated models. While first differencing removes the country specific effects from the first model, the other models are two-way error component estimators. Therefore, for models 2 to 5 we test whether the explanatory variables and individual effects are correlated using a modified Hausman (1978) test to ascertain whether we should employ the Within or random effects GLS estimator. We reject the null hypothesis of no correlation in all cases.

Estimation Results

The estimation results for the five models are presented in Table 4. The most important result, for our interest, is that obtained for the fiscal decentralization variable (*Dec*). The coefficient β_{Dec} is positive and highly statistically significant in all models. As discussed previously, due to the fractional nature of the dependent variable, model 4 provides the estimated coefficients and the marginal effects, the latter being more appropriate for interpreting the results. The magnitude of the *Dec* marginal effect ranges from $\hat{m}_{Dec} = 0.24$ to $\hat{\beta}_{Dec} = 0.38$. Thus the QMLE model predicts an increase of 2.4 percentage points in the composition of expenditures variable when the level of decentralization increases from *Dec*=0.26 (the mean value) to *Dec*=0.36. This is significantly lower than the 3.8 percentage point increase predicted by the least-squares dummy variable (the closest in methodology employed for other econometric issues) and still lower than the 3.1 and 2.9 percentage points increase predicted by the within and random effects error components specifications, respectively.[36]

The marginal effects of the MQLE are defined as: $\partial E(y|x)/\partial x_j = m_j = g(x\beta)\beta_j$, where $g(z) = dG(z)/dz = \exp(z)/[1+\exp(z)]^2$. Since $g(z) \to 0$ as $z \to \infty$, the marginal effects

[36] As expected, due the serial correlation problem, the standard errors of the QMLE that were not corrected for positive serial correlation are underestimated, leading to higher *z*-statistics. The values of *z* statistics for the serial correlation-robust variance covariance matrix and the white robust z statistics are also reported in Table 4.

decrease as the values of the explanatory variables get larger. In order to find the marginal effects, we must choose values for the explanatory variables to estimate a scalar value for $g(x\beta)$, which then is multiplied to each variables coefficient. For this, we chose the mean values of the explanatory variables, as reported in the descriptive statistics (Table 2). With the mean values of the explanatory variables the linear prediction is $\bar{x}\hat{\beta}$ = -1.1845, and $g(\bar{x}\hat{\beta}) = .1794$. We examine the non-linear nature of the estimated marginal effects of the decentralization variable; this is done by maintaining the mean for control variables and while estimating the marginal effects for alternative degrees of decentralization. In order to evaluate the marginal effects for higher values of decentralization, we add a standard deviation to the mean value of the *DEC* variable (*DEC* =.259+.152 ≈.41). Similarly, to evaluate the marginal effects at lower values of decentralization we subtract a standard deviation to the mean value of the decentralization variable (*DEC* =.259-.152 ≈.11). The scalar $g(\bar{x}\hat{\beta})$ calculated at *DEC*=.11 is lower than the one calculated at the mean (DEC=.26). For *DEC*=.11 the linear prediction scalar is $\bar{x}\hat{\beta}$ = -1.3874, and $g(\bar{x}\hat{\beta}) = .1599$. In a similar way, the marginal effects for *DEC*=.41 are higher than those calculated at the mean. For *DEC*=41 the linear prediction scalar is $\bar{x}\hat{\beta}$ = -.9872, and $g(\bar{x}\hat{\beta}) = .1978$.[37] Table 5 summarizes these results. Summarizing, the effect of fiscal decentralization on the composition of expenditures increases with higher values of decentralization.[38]

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[37] The scalar values used $g(\bar{x}\hat{\beta})$ in each case can be easily verified by multiplying any variable's coefficient by the reported $g(\bar{x}\hat{\beta})$ then compare this value to the marginal effects listed on table 4 for that variable. For more details in the derivation of marginal effects see appendix J and K.

[38] These may seem contradictory with the fact that the MQLE marginal effects are decreasing on the chosen values of the explanatory variables since $g(z) \to 0$ as $z \to \infty$. Where $g(z) = dG(z)/dz = \exp(z)/[1+\exp(z)]^2$. However, it is important to note that *g(z)* is increasing for negative values of *z* until it reaches a maximum at *z*=0.

Let us now turn to the other explanatory variables. The parameter for the interaction term for fiscal decentralization and industrial country status is negative and weakly significant in the QMLE model and negative and statistically significant in model one, suggesting that decentralization's influence on expenditure composition may be attenuated in industrialized countries.

The coefficient for GDP per capita is negative and statistically significant at the one percent level in the QMLE and mostly negative but although not statistically significant in the other models. This result may be due to the impact of private education and health services on the growth of public education and health services as a country's per capita income increases. [39]

The positive and statistically significant coefficient for the budget balance in the QMLE and other three models suggests that education and health expenditures are vulnerable to cuts in times of economic crisis (Snyder and Yackovlev, 2000 and IMF 2003). Using the marginal effect for the QMLE model, a one percent decrease in the budget balance would lower health and education expenditures as percentage of total expenditures by 0.10 percent. The marginal effects for the first difference and error components specifications models yield similar results. Health and education expenditures would appear to fall at a greater rate than other components of total expenditures in times of economic turmoil.

The parameter estimate for population is negative and statistically significant for the QMLE model and three other models. This suggests that there may be a greater 'fixed cost effect' in the provision of education and health services vis-à-vis other public expenditures..[40]

[39] There is some evidence that public health and education services may have lower income elasticity than other public expenditures (see Bahl et al., 2002).

[40] There is empirical evidence that population tends to be negatively correlated per capita expenditures for most public services. See Murdoch and Sandler (1984), Gertham, Jonsson and Anderson (1992), Falch and Rattso (1999), Marlov and Shiers (1999), Snyder and Yackovelev (2000).

The parameter estimates for population density is generally statistically insignificant, including the that for the QMLE model.

In summary, we find robust statistical evidence from cross country panel data that decentralization affects the composition of public expenditures increasing the share of publicly provided private goods, as captured by public education and health. These results offer strong support to our theoretical model.

5. Conclusion

This paper set out to offer an indirect test of the allocative efficiency effects of decentralization by examining the role of decentralization on the composition of public expenditures. We investigate this issue from a theoretical viewpoint by by means of a distance-sensitive representative agent model. By employing a two-dimensional space country framework we are able to integrate two features of fiscal decentralization: the distribution of expenditure assignments between two levels of government and the composition of public expenditures into two types of public goods. The approach allows us to represent the heterogeneous nature of tastes within a representative agent model. Among other implications of the model, we finds that decentralization leads to higher levels of publicly provided private goods and to a higher share of publicly provided private goods in total government expenditures. The model predictions are strongly supported by our empirical analysis based an unbalanced panel data set spanning 45 developed and developing economies over a period of 28 years.

The policy implications of our findings are intriguing. Decentralization trends all over the world are likely to result in a reallocation of resources in the public sectors from centrally provided PPGs to subnationally provided PPPGs. This higher emphasis on expenditures on

education and health may not only yield increases in allocative efficiency and overall welfare, but also may support national efforts for poverty alleviation and improving economic growth.

Table 1.
Description of Variables

Variable	Label	Definition	Units	Source
Expenditure composition	COMP	$\frac{EducationE\ xp + HealthExp}{TotalExp}$	Fraction (0-1)	Calculated from GFS
Fiscal Decentralization	DEC	$\frac{SubnationalExp.}{NationalExp.}$	Fraction (0-1)	Calculated from GFS
Budget Deficit	BUD	Current and capital revenue and official grants received less total expenditure and lending minus repayments as a percentage from GDP	Fraction (0.1)	World Bank Indicators (2002)
Population	POP	Total country population	10 millions	World Bank Indicators (2002)
Density	DENS	Total population divided by land area in square kilometers	Thousands	World Bank Indicators (2002)
Per Capita GDP	GDPPC	Gross Domestic Product divided by midyear population	One hundred thousand constant 1995 U$	World Bank Indicators (2002)
Decentralization development interaction term	DEV	DEC x Industrial Dummy (=1 for industrialized countries)	(0-1)/0	Calculated from GFS & WBI (2002)

Variables which source is the World Bank have the definitions provided by the World Bank Indicators (2002).

Table 2.
Descriptive Statistics

Series	N	Mean	Standard Deviation	Minimum	Maximum
Expenditure composition	614	.235	.072	.086	.538
Fiscal Decentralization	614	.259	.152	.017	.591
Budget Deficit	614	-.027	.039	-.267	.090
Population	614	.573	1.526	.002	9.624
Density	614	.101	.107	.001	.579
Per Capita GDP	614	.132	.122	.002	.456

Find definition of variables and units defined in Table1.

Table 3. **Summary of corrections and specification modeling of econometric issues.**					
Econometric Issues	Model 1	Model 2	Model 3	Model 4	Model 5
	First Differences	**AR(1) Fixed Effects**	**AR(1) Random Effects**	**QMLE**	**Fixed Effects**
Estimation	Linear (OLS)	Linear (OLS)	Linear (OLS)	Non-linear (Maximum Likelihood)	Linear (OLS)
Serial Correlation	First Differences	Serial correlation assumed Ar(1)	Serial correlation assumed Ar(1)	Serial Correlation-Robust standard errors	Serial Correlation-Robust standard errors
Heteroskedasticity	White's (1980) robust var/cov matrix	White's (1980) robust var/cov matrix	White's (1980) robust var/cov matrix	White's (1980) robust var/cov matrix	White's (1980) robust var/cov matrix
Unobserved country effects	Not Applicable due to first differencing	Within Transformation, Assumed correlated with the explanatory variables, demeaned variables	Random Transformation, Assumed uncorrelated with the explanatory variables, quasi-demeaned variables	Full set of Country dummies, no constant term.	Full set of Country dummies, no constant term.
Unobserved Time effects	Time Dummies	Time Dummies	Time Dummies	Time Dummies	Time Dummies
Dependent variable	Dependent variable Transformed (-1,1)	Transformed demeaned	Transformed Quasi demeaned in proportion to parameter (theta)	(0-1)	(0-1)
Fitted values	Not guaranteed to lie on the unit interval	Not guaranteed to lie on the unit interval	Not guaranteed to lie on the unit interval	$E(y\|x)=G(x\beta)$ where $G(\cdot)$ is the logistic transformation $0 < G < 1$.	Not guaranteed to lie on the unit interval

Table 4.
Estimated Coefficients Composition of Public Expenditures

Dependent Variable: Expenditures in health and education services as a % of Total Expenditures

Variable	First Differences	Fixed Effects (AR1)	Random Effects (AR1)	QMLE		Fixed Effects (Country dummies)
	Model 1	**Model 2**	**Model 3**	**Model 4**		**Model 5**
				β_k	m_k	
Fiscal Decentralization	.38 (4.88)	.31 (7.55)	.29 (8.00)	1.33 (4.88) [2.78]	.24 (4.88)	.38 (8.22) [4.68]
Interaction Term (Dec * Ind. Dummy)	-.18 (-2.04)	-.01 (-.89)	-.01 (-.58)	-.18 (-1.73) [-1.61]	-.03 (-1.73)	.01 (.44) [.34]
GDP Per Capita	.16 (0.89)	-.07 (-.67)	-.11 (-1.53)	-4.01 (-8.71) [-3.87]	-.71 (-8.69)	-.13 (-1.85) [-.92]
Budget Balance	.15 (3.63)	.15 (5.07)	.14 (4.51)	.58 (2.39) [1.44]	.10 (2.38)	.03 (0.61) [.27]
Density	.67 (1.58)	.02 (.07)	-.05 (-.69)	-.06 (-.06) [-.02]	-.01 (-.06)	.68 (5.20) [2.96]
Population	-.03 (-1.65)	-.01 (-.74)	-.02 (-2.73)	-.16 (-3.82) [-1.53]	-.03 (-3.81)	-.04 (-6.80) [-3.30]
Constant	.009 (2.63)	-.03 (-4.08)	.16 (9.65)	no const.	no const.	no const.
R^2	.23	.37	.24	.88		.89
Number of Observations	568	568	568	614		614

The quantities in (.) are the White corrected t-statistics for the OLS, and z for the QMLE; the quantities in [.] are the White corrected *t*-statistics robust to variance misspecification for the OLS, and the White corrected *z*-statistics robust to variance misspecification for the QMLE. Serial correlation coefficient for models 2 and 3 , $\hat{\rho}$ =.79.

Table 5.
Quasi maximum Likelihood
Marginal effects and elasticities Composition of Public Expenditures (Model 4)

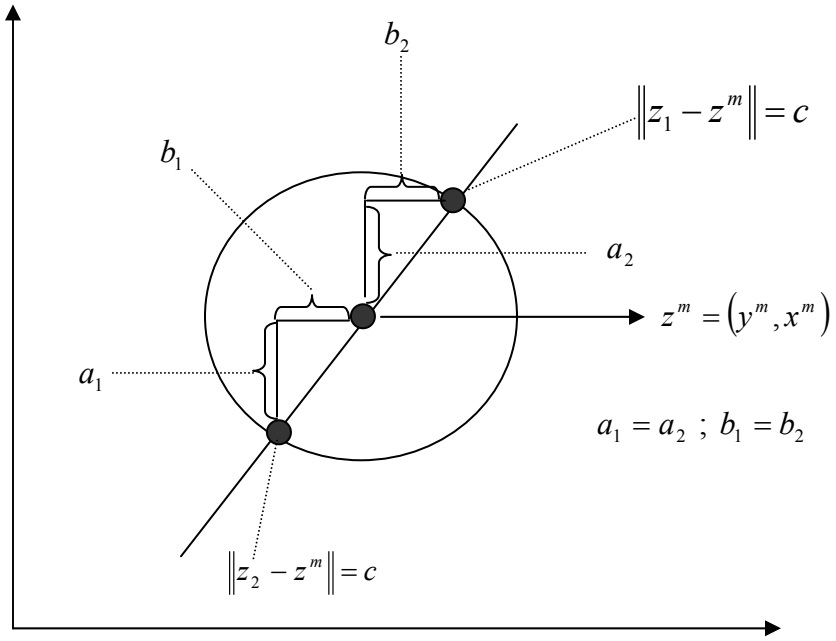
Dependent Variable: Expenditures in health and education services as a % of Total Expenditures

Variable	Coefficient	Marginal effect at mean values $\bar{x}$	Elasticity at mean values $\bar{x}$	Marginal effect at mean values $\bar{x}$, Dec=.11	Marginal effect at mean values $\bar{x}$, Dec=.41
Fiscal Decentralization	1.334**	.2393**	.2674**	.2134**	.2639**
	(.2734)	(.0490)	(.0548)	(.0384)	(.0590)
Interaction Term (Dec * Ind. Dummy)	-.1778+	-.0319+	-.0230+	-.0284+	-.0352+
	(.1026)	(.0184)	(.0132)	(.0164)	(.0204)
GDP Per Capita	-4.0075**	-.7190**	-.3863**	-.6410**	-.7928**
	(.4603)	(.0827)	(.0443)	(.0681)	(.0987)
Budget Balance	.5846*	.1049*	-.0128*	.0935*	.1157*
	(.2451)	(.0440)	(.0053)	(.0397)	(.0482)
Density	-.0612	-.0110	-.0047	-.9782xE-2	-.0121
	(1.092)	(.1960)	(.0849)	(.1747)	(.2162)
Population	-.1653**	-.0296**	-.0756**	-.0264**	-.0327**
	(.0433)	(.0078)	(.0198)	(.0070)	(.0085)

The quantities in (.) are the white corrected standard errors. **,*,+ denote significance at the 1%,5%, and 10% level respectively.

Figure 1. Median to the Median in a Two Dimensional Space

Pure Public Good



Publicly Provided Private Good

Appendix 1.

Table A.1
Deciding the Type and the Quantity of Public Goods

Decision		Type		Quantity	
		Who is the key decision maker?	**Where is the location of the key decision maker?**	**Who is the key decision maker?**	**Where is the location of the key decision maker?**
Pure Public Goods		Type national median voter	Middle of the country (vertical axis).	Quantity national median voter. Determined by the distance to the national median (vertical axis).	Median distance to the country median (vertical axis).
PPPG's	**Share θ**	Type national median voter	Middle of the country (horizontal axis).	Quantity national median voter. Determined by the distance to the country median (horizontal axis).	Median distance to the country median (horizontal axis).
	Share (1-θ)	Type jurisdiction median voter	Middle of the jurisdiction (horizontal axis).	Quantity jurisdiction median voter. Determined by the distance to the middle of the jurisdiction (horizontal axis).	Median distance to the jurisdiction median. (horizontal axis).

Appendix 2

Proof of Proposition 1

$$\frac{\partial g_i^*}{\partial \theta} = \frac{\delta_\theta y(\delta+\beta+\gamma) - \delta\ y\delta_\theta}{(\delta+\beta+\gamma)^2} = \frac{\delta_\theta y\delta + \delta_\theta y\beta + \delta_\theta y\gamma - \delta\ y\delta_\theta}{(\delta+\beta+\gamma)^2}$$

$$= \frac{\delta_\theta y(\delta+\beta+\gamma-\delta)}{(\delta+\beta+\gamma)^2} = \frac{y\delta_\theta(\beta+\gamma)}{(\delta+\beta+\gamma)^2} \tag{5}$$

$$\text{If } J > 1, \text{ then } \delta_\theta = -\alpha(x_{ic} - x_{ij}) < 0 \tag{6}$$

$$\text{and } \frac{\partial g_i^*}{\partial \theta} < 0$$

Proof of Proposition 2

$$\frac{\partial s}{\partial \theta} = -\frac{\gamma\ y\ \delta_\theta}{(\delta+\beta+\gamma)^2} \tag{7}$$

$$\text{given that } \delta_\theta < 0 \Rightarrow \frac{\partial s}{\partial \theta} > 0.$$

Proof of Proposition 3

Given normalized prices total expenditures must decrease, and the ratio PPPG to total expenditures must necessarily increase with decentralization. Taking the first derivative of the PPPG to total expenditures ratio with respect to decentralization, we note:

$$\frac{\partial(g^*/(g^*+s^*)}{\partial \theta} = \frac{g_\theta(g+s) - g(g_\theta+s_\theta)}{(g+s)^2} = \frac{g_\theta g + g_\theta s - g g_\theta - g s_\theta}{(g+s)^2}$$

$$= \frac{g_\theta(g+s-g) - g s_\theta}{(g+s)^2} = \frac{g_\theta s - g s_\theta}{(g+s)^2}$$

Since $g_\theta < 0$, $s_\theta > 0$, $(g_\theta s - g s_\theta) < 0$ $(g+s)^2 > 0$ which implies $\frac{\partial(g^*/(g^*+s^*)}{\partial \theta} < 0.$

Proof of Proposition 4

$$\frac{\partial(g+s)}{\partial\,\theta} > 0. \quad (8)$$

Given propositions 1 and 2, $\frac{\partial g_i}{\partial\,\theta} < 0$, $\frac{\partial\, s}{\partial\theta} > 0$, the sign of equation 8 is positive if $\left|\frac{\partial g_i}{\partial\,\theta}\right| < \left|\frac{\partial s}{\partial\theta}\right|$.

Rewriting equation (7) in terms of $\frac{\partial g_i}{\partial\,\theta}$ (equation 5) as:

$$\frac{\partial\, s}{\partial\theta} = -\frac{\gamma\ y\ \delta_\theta}{(\delta+\beta+\gamma)^2} = -\left[\frac{\partial g}{\partial\theta} - \frac{y\delta_\theta\beta}{(\delta+\beta+\gamma)^2}\right]$$

$$\frac{\partial\, s}{\partial\theta} = -\frac{\partial g}{\partial\theta} + \frac{y\delta_\theta\beta}{(\delta+\beta+\gamma)^2} \quad (9)$$

Define a constant $c = \frac{y\delta_\theta\beta}{(\delta+\beta+\gamma)^2}$; rearranging equation (9): $\frac{\partial\, s}{\partial\theta} + c = -\frac{\partial g}{\partial\theta}$ or

$\left|\frac{\partial g_i}{\partial\,\theta} - c\right| = \left|\frac{\partial s}{\partial\theta}\right|$, given equation (6), $\delta_\theta < 0 \Rightarrow c < 0$ hence $\left|\frac{\partial g_i}{\partial\,\theta}\right| < \left|\frac{\partial s}{\partial\theta}\right|$.

Appendix 3

Table A.2

Available Decentralization Data: Government Finance Statistics (1972-2000)

Country	Years	Country	Years
Albania	1995-1998	Latvia	1996-2000
Argentina	1978-2000	Lithuania	1991-2000
Australia	1972-1999	Luxembourg	1972-1997
Austria	1972-2001	Malaysia	1972-1987
Azerbaijan	1993-2000	Mauritius	1972-2000
Bahrain	1972-2000	Mexico	1972-1999
Belgium	1972-1998	Moldova	1995-2001
Belarus	1992-2000	Mongolia	1992-2000
Bolivia	1985-2000	Netherlands	1973-1997
Brazil	1980-1998	New Zealand	1972-2000
Bulgaria	1993-2000	Norway	1972-1998
Canada	1974-2000	Panama	1973-1999
Chile	1972-2000	Peru	1972-2000
Costa Rica	1972-2000	Paraguay	1972-1993
Czech Republic	1993-2000	Philippines	1972-2000
Croatia	1993-2000	Poland	1984-2000
Denmark	1972-2000	Portugal	1973-1998
Dominican Republic	1972-1999	Rumania	1972-1999
Estonia	1991-2000	Russian Federation	1994-2000
Fiji	1972-1996	Senegal	1972-2000
Finland	1972-1998	Slovak Republic	1996-2000
France	1972-1997	Slovenia	1992-2001
Georgia	1997-2000	South Africa	1972-2000
Germany	1972-1999	Spain	1972-1997
Hungary	1981-2000	Sweden	1972-1999
Iceland	1972-1998	Switzerland	1972-1999
India	1974-2000	Tajikistan	1998-2000
Indonesia	1972-1999	Thailand	1972-2000
Ireland	1972-1997	Tunisia	1972-2000
Israel	1972-2000	Ukraine	1999-2000
Italy	1973-1999	United Kingdom	1972-1999
Kazakhstan	1997-2000	USA	1972-2000
Kenya	1972-1998	Uruguay	1972-2000
Kyrgyz Republic	1993-2000	Zimbabwe	1976-1989

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