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Abstract

This paper empirically examines the relationship between fiscal decentralization and public sector efficiency. A country-level dataset is used to measure public sector efficiency in delivering education and health services and the new indices are regressed on well-established decentralization measures. The analysis is carried out for 21 OECD countries, between 1970 and 2000. Irrespective of whether public sector efficiency concerns education or health services, an inverted U-shaped relationship has been identified between government efficiency in providing these services and fiscal decentralization. This relationship is robust across several different specifications and estimation methods.

Keywords: Public sector efficiency; fiscal decentralization; OECD countries
JEL classification: C14; C24; H11; H50

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1. Introduction

It has long been recognized that governments differ significantly in the efficiency of delivering public services (ref. Tanzi and Schuknecht, 1998; Afonso *et al.,* 2005). Some are extremely wasteful and ineffective in performing even basic activities, whereas others achieve their objectives systematically and comprehensively. The efforts to increase government productive efficiency, otherwise termed public sector efficiency (hereafter referred to as PSE), has spawned an output of vital theoretical literature on channels that may affect it. One of the most prominent channels is the design of fiscal relations across the various levels of government. This study empirically examines the relationship between PSE and fiscal decentralization, using country-level macroeconomic data on OECD countries.

The theoretical literature on fiscal federalism identifies two benchmark channels through which fiscal decentralization is expected to affect PSE positively, namely (i) increased electoral control and (ii) yardstick competition among local governments that results from decentralization.[1] According to the electoral control mechanism, decentralization reduces the inclinations of officials to divert rents, and increases the probability of "bad" incumbents to be voted out of office, thus positively affecting the overall government efficiency (Hindriks and Lockwood, 2009). Moreover, Seabright (1996) shows that rent-seeking politicians, when contesting in decentralized elections, use incentives to lure the voters in each (local) constituency. In contrast, to get re-elected in the national elections politicians would seek to please the voters only in a majority of the localities. Similar results are obtained by Hindriks and Lockwood (2009) and Myerson (2006). According to the theory of yardstick competition (see e.g., Shleifer, 1985; Besley and Case, 1995), citizens are at an advantage when they are able to evaluate the performance of their policy makers by comparing the policy choices of their own political representatives with the corresponding choices of the neighboring regions' policy makers. Therefore, fiscal decentralization may increase PSE, as it offers citizens an opportunity to compare public services and taxes across jurisdictions and helps them to assess whether their government wastes resources through low human capital capacity or rent-seeking (Besley and Smart, 2007).

[1] Barankay and Lockwood (2007) suggest an additional mechanism through which fiscal decentralization may lead to increased efficiency, namely a decrease in lobbying by local interest groups. However, as the theoretical literature (e.g., Bardhan and Mookherjee, 2000; Bordignon *et al.,* 2003; Redoano, 2003) appears to be rather inconclusive on this issue (mainly because under certain conditions there may be more lobbying with decentralization), we prefer not to refer to this mechanism as benchmark.

However, fiscal decentralization may also exert a negative impact on government efficiency. This impact can be attributed to a number of potential advantages gained by the provision of public goods by central governments. First, in the presence of economies of scale, higher decentralization might lead to a higher average cost of production for the public good (Stein, 1997). Second, national government bureaucracies are more likely to offer talented people better careers and promotion opportunities, which in turn attract higher quality individuals (Prud'homme, 1995). Finally, other scholars emphasize the potential danger that local politicians and bureaucrats are likely to face, particularly an increase in pressure from local interest groups, with these groups being more influential when the size of the jurisdiction is small (Bardhan and Mookherjee, 2000; Prud'homme, 1995).

As the discussion above indicates, the theoretical literature is inconclusive about the relationship between fiscal decentralization and PSE. If the above considerations were to be consolidated, it becomes logical to argue that fiscal decentralization involves both negative and positive forces on PSE. Therefore, such arguments could also indicate a potential non-linearity. Particularly, in relatively centralized systems, an increase in the degree of fiscal decentralization can induce some costs due to diseconomies of scale in the provision of the public good, therefore reducing PSE; however, it will also create large gains from an increased electoral accountability. Interestingly, in highly decentralized jurisdictions, further increases in decentralization imply that diseconomies of scale would prevail over the positive effects of electoral accountability, consequently lowering PSE. Therefore, if both views are legitimate, at least to some degree, then an inverted U-shaped relationship can be expected between fiscal decentralization and PSE.

Over the recent years, a small, albeit growing, body of empirical work on the quality of governance-fiscal decentralization nexus (Fisman and Gatti, 2002a; Enikolopov and Zhuravskaya, 2007) has been observed. Most of these studies measure the quality of governance by some internationally comparable outcome of government policy, such as infant mortality, the literacy ratio, immunization of population, etc. Also, the key explanatory variable is fiscal decentralization, measured as the ratio of sub-national government expenditures (resp. tax revenues) to total public spending (resp. tax revenues). Although these studies offer contradicting evidence concerning the relationship between the outcomes of government policy and fiscal

decentralization, the relationship identified (positive or negative) is always linear.[2] However, the theoretical hypotheses postulated above are probably not comprehensively addressed by employing socioeconomic indicators as measures of "good governance". This is because such measures do not encompass the size of government spending and thus fail to reflect the level of efficiency in delivering government services. Barankay and Lockwood (2007) state, "[…] these regressions do not estimate government "production functions" because they do not control for the inputs to the output that is the dependent variable. […] In the absence of controls for these inputs, these regressions cannot tell us much about the efficiency of government, as any observed correlation between decentralization and government output can be due to omitted variable bias."

To cope with this problem, we develop direct measures of PSE by employing data envelopment analysis (DEA) on a panel of 21 OECD countries, between 1970 and 2000. The PSE measures are constructed using information on the "inputs" and "outputs" of the public sector. Within this framework, we implicitly assume that these indicators are derived from an underlying government production relationship. We focus on public education and health and construct two alternative PSE indices reflecting government efficiency in delivering services in these two sectors. Subsequently, we use the PSE indices to identify the potential public sector efficiency-fiscal decentralization nexus.

We find that PSE increases with the degree of fiscal decentralization up to a certain degree of decentralization and thereafter decreases, i.e. revealing an inverted U-shaped relationship. This result appears to be robust across a number of different specifications and estimation methods that account, *inter alia*, for the potential reverse causality between fiscal decentralization and PSE. Notably, this is the first study to identify such a non-linear pattern, a finding consistent with both contradicting stands of the theoretical literature. Also, we are able to calculate the particular level of decentralization at which the relationship at hand turns negative and relate this value to certain countries.

[2] Fisman and Gatti (2002a) and Mello and Barenstein (2001) find that increased decentralization (measured as the budgetary share of subnational governments) is associated with lower levels of corruption. Similarly, Fisman and Gatti (2002b) and Henderson and Kuncoro (2004) using sub-national data for the US and Indonesia, respectively, show that decentralization of public expenditure is effective in reducing corruption only if it is accompanied by an increase in power to raise revenue (i.e. increased tax autonomy). Robalino *et al.,* (2001) and Khalegian (2003) in cross-country studies, also find support that fiscal decentralization is associated with lower infant mortality and immunization rates (taken as measures of the quality of governance). Finally, Enikolopov and Zhuravskaya (2007) examine the effect of decentralization on a set of four indicators of governance quality (namely the three indicators used in the studies reviewed above, plus the illiteracy ratio) and conclude that the effects of fiscal decentralization are beneficial only in countries that are also characterized by a high degree of political centralization.

The rest of the paper includes: Section 2, which describes the empirical model and data used in this empirical analysis; Section 3, which illustrates the various econometric methodologies employed, as well as discusses the empirical results; and Section 4, which presents the conclusions drawn.

2. Empirical model and data

The empirical model used to study the relationship between fiscal decentralization and public sector efficiency is as follows,

$$pse_{it} = \alpha_0 + \beta_1 decentralization_{it} + \beta_2 decentralization_{it}^2 + \beta_k controls_{it} + u_{it} \quad , \qquad (1)$$

where public sector efficiency pse_{it} in country i at time t, is expressed as a function of fiscal decentralization, a set of control variables and a stochastic term u_{it}. The inclusion of the quadratic term reflects the expected inverted U-shaped relationship between PSE and decentralization, as discussed in the introduction. To estimate Eq. (1) we first construct the PSE indicators. Next, we discuss the data on the variables used in this study.

We build a panel dataset of 21 OECD countries[3] spanning the 1970-2000 period. The reason for such a choice is because reliable data are available for these countries to construct the PSE indicators and obtain the main explanatory variables for the empirical analysis. The final sample is an unbalanced one, comprising a maximum of 522 annual observations. The dependent and explanatory variables are discussed below. Explicit definitions and sources for the variables used are provided in Appendix A and the descriptive statistics are reported in Table 1.

2.1. Measurement of public sector efficiency

The measurement of PSE and the resulting comparison of the individual countries in the context of the efficient functioning of their public sectors, presents a number of difficulties related to the scarcity of publicly available country-level data and the complicated problems that may emerge in the estimation procedure. In this study, we opt for a direct estimation of PSE, using the linear programming technique of Data Envelopment Analysis (DEA).[4] DEA is a linear

[3] The set of countries includes Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, UK and USA.

[4] A number of recent studies instigated an effort towards the computation of PSE indicators using DEA. Concerning OECD economies, Afonso *et al*., (2005) estimate relative efficiency scores for several parts of the public sector during the 1980s and the 1990s, while Afonso and St. Aubyn (2005) focused on the efficiency of government

programming technique that provides a piecewise frontier, by enveloping the observed data points and yields a convex production possibilities set (for a thorough discussion, see Coelli *et al.,* 2005). As such, it does not require the explicit specification of a functional form of the underlying production relationship. To introduce some notation, let us assume that for N observations there exist M inputs in the production of public goods, yielding S outputs. Hence, each observation n uses a nonnegative vector of inputs denoted $x^n = (x_1^n, x_2^n, ..., x_m^n) \in R_+^M$ to produce a nonnegative vector of outputs, denoted $y^n = (y_1^n, y_2^n, ..., y_S^n) \in R_+^S$. Production technology $F = \{(y, x) : x \text{ can produce y}\}$ describes the set of feasible input-output vectors.

To measure productive efficiency we an input-oriented DEA model[5] of the following form (for exposition brevity subscripts t are dropped):

$$
\begin{aligned}
& pse_i^* = \min pse_i, \text{ s.t.} \\
& \sum_{j=1}^{n} k_j x_{ji} \le pse_i x_{i0} \quad i = 1, 2, ..., m; \\
& \sum_{j=1}^{n} k_j y_{rj} \ge y_{r0} \quad r = 1, 2, ..., s; \qquad (2) \\
& \sum_{j=1}^{n} k_j = 1 \\
& k_j \ge 0 \qquad j = 1, 2, ..., n;
\end{aligned}
$$

where public sector 0 represents one of the N public sectors under evaluation, and x_{i0} and y_{r0} are the ith input and rth output for public sector 0, respectively. If $pse_i^* = 1$, then the current input levels cannot be proportionally reduced, indicating that public sector 0 is on the frontier. However, if $pse_i^* < 1$, then public sector 0 is inefficient and pse^* represents its input-oriented efficiency score. Thus, $pse \in [0.1]$. Finally, k is the activity vector denoting the intensity levels at which the N observations are conducted. Note that this approach, through the convexity

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spending on education and health. Using similar techniques, Gupta and Verhoeven (2001), Sijpe and Rayp (2007) and Afonso *et al.*, (2006) focused on developing countries. Finally, Balaguer-Coll *et al.,* (2007) considered using DEA to analyze the efficiency of local governments in Spain.

[5] DEA may be computed either as input or output oriented. Input-oriented DEA shows by how much input quantities can be reduced, without varying the output quantities produced. Output-oriented DEA assesses by how much output quantities can be proportionally increased, without changing the input quantities used. The two measures provide the same results under constant returns to scale but give slightly different values under variable returns to scale. Nevertheless, both output and input oriented models will identify the same set of efficient/inefficient public sectors (see Coelli *et al.,* 2005). Also, a constant returns to scale assumption is only appropriate when all public sectors are operating on an optimal scale (imperfections, asymmetries, etc. are not present), and therefore, we select a variable returns to scale specification.

constraint $\Sigma k = 1$ (which accounts for variable returns to scale) forms a convex hull of intersecting planes, as the frontier production plane is defined by combining some actual production planes.

To measure PSE we need to focus on specific areas of government activity. As it is impossible to consider all the areas of government activity and the corresponding government output, we construct two alternative PSE indicators as proxies of PSE: (i) PSE in providing education services and (ii) PSE in providing health services. In our view these two areas of government activity have the advantage that the output of both areas is directly measurable.[6]

Following the rationale of the relevant literature (see e.g., Afonso *et al.,* 2005; Adam *et al.,* 2010), we employ the following measures.[7] As an output of public education spending, we use the years of schooling provided by Barro-Lee (2001) multiplied by the educational quality indicator "*cognitive*" developed by Hanushek and Woessmann (2009). The *"cognitive"* indicator allows us to capture potential qualitative differences on education among different countries. Besides, as the educational systems of the OECD countries are far from being homogeneous in the sources of spending (private or public), it becomes important to account for the different shares of private to public spending on education.[8] As such, we multiply the outputs of public education spending (i.e. years of schooling multiplied by *cognitive*) by the ratio of public to total spending. Thus, we isolate the impact of private expenditure on output and consequently, we don't give countries characterized by heavy private funding on education an undue advantage.

As an output of public spending on health, we employ the inverse of the infant mortality rate at birth (taken from OECD Health Data, 2007). As in the case of education, we account for differences in the shares of private to public spending on health by multiplying the output of public spending on health by the ratio of public to total spending on health.[9]

[6] To clarify this argument, consider for example the case of national security, where the proper performance measure / government output would have been the avoidance of external and internal conflicts.

[7] For details on the methodology used and for the summary statistics for the variables employed as outputs and inputs, see Appendix A.

[8] In this sample countries characterized by heavy private funding on education such as Australia or the United States are included, as well as countries that base the financing of their educational systems on public funds, such as Finland and Denmark.

[9] The ratio of public to total spending on health is 41.6% in the United States and 51.9 % in Greece, while it reaches 88.42% and 87.32% in Sweden and Norway, correspondingly.

As input, in the case of PSE in education, we employ public education spending as a share of GDP (taken from Busemeyer, 2007), whereas in the case of PSE in health, we employ public spending on health as a share of GDP (taken from OECD Health Data, 2007).

Estimation of program 2 is carried out on annual data to obtain annual indices of PSE in providing public education and health services. A panel data approach is used and, therefore, the frontier is shaped (is different) at each point in time (each year). We end up with 492 observations for the PSE education variable and with 597 observations for the PSE health variable (see Table 1 for summary statistics). Space constraints prevent reporting the yearly values of the indices; therefore, 10-year averages are presented for each country in Fig. 1 (the full set of results is available on request). The first set of graphs presents PSE index in providing education services (PSE education), while the second set shows the PSE index in providing health services (PSE health). Missing values on the PSE indices for some countries reflect missing data for the input or the output of the production process. The PSE education figures indicate that in the 1970s and 1980s, Australia, Japan, Switzerland and USA reflected high efficiency scores, while in earlier years Norway gained much ground. The results are similar in the PSE health figures, the exception being Greece and Finland, which were among the best-performing countries. Overall, these results appear to be reasonable approximations of prior academic belief and concur with the findings of earlier research (see e.g., Afonso *et al.*, 2005). The yearly values of PSE education and PSE health are used as the dependent variable in the subsequent empirical analysis.

2.2. Fiscal decentralization measures

Approximating the degree of fiscal decentralization has been an issue of considerable disagreement in empirical studies. In this paper, we follow the method adopted by Stegarescu (2005), who develops a measure of fiscal decentralization based on the detailed data provided by OECD (1999). The advantage of the OECD (1999) survey is that it very analytically classifies sub-national government taxes based on the degree of decision-making autonomy. Specifically, it separates taxes that are set by sub-central governments (i.e. sub-central governments determine the tax rate and the corresponding tax base) from those that are determined by the central government at a national level and in turn shared with sub-national units. Therefore, Stegarescu's measure of fiscal decentralization reflects the "real" tax-raising autonomy of sub-national units,

as it includes as local tax revenues only those taxes strictly determined by sub-national governments. This measure has been used in the works by Stegarescu (2005; 2009) and Fiva (2006). As a sensitivity analysis we also experiment with the budgetary share of sub-national units as recorded by the IMF's Government Financial Statistics (GFS).[10]

The tax revenue decentralization indicator of Stegarescu is referred to as *taxrevdec*, while the GFS decentralization indicator as *decindex*. For explicit definitions of these measures, see Appendix B. Higher values on the two indices reflect higher levels of decentralization. Countries with a high level of fiscal decentralization are Switzerland, Canada and Sweden, while Austria, Ireland and Netherlands show a low degree of decentralization. Overall, 522 observations are available for the *taxrevedec* index, while a smaller number of observations (481) are available for the *decindex* index.

2.3. Control variables

To ensure robust econometric identification, we use a number of control variables in the estimated equations. First, to control for the overall level of productivity and wealth in the economy, we employ the log of real GDP per capita. Data for this variable is from the World Banks', World Development Indicators (WDI) (2004). Countries with higher real income are expected to have a more productive private and public sector. In addition, we account for the presence of economies of scale in the production of the public good at the country level, by controlling for (i) the logarithm of total population, (ii) population density (measured by the number of people per square km) and (iii) the share of urban population to total population. Data for these variables are from the WDI. Higher values for these variables imply higher potential economies of scale in the production of public goods, and thus we expect them to be positively associated with PSE indicators.

[10] The GFS measure has been employed in Jin and Zou (2002), Davoodi and Zou (1998), Fisman and Gatti, (2002a), Enikopolov and Zhuravskaya (2007). However, this widely employed measure includes major shortcomings, as it fails to integrate vital aspects of intergovernmental relations. Most importantly, it fails to capture the real degree of sub-national governments' autonomy that is to reflect the degree to which decisions regarding revenues and expenditures are truly assigned to lower levels of government (see, Ebel and Yilmaz, 2003; Stegarescu, 2005; Barankay and Lockwood, 2007). Evidently, Stegarescu (2005) finds that the GFS measure of tax revenues' decentralization overestimates the extent of fiscal decentralization. This is evident, particularly in the case of Austria (28.4% versus 3.5%), Belgium (44.4% versus 24.6%) and Germany (49.4% versus 7.3%). The percentages refer to data for the year 2000.

According to Alesina *et al.* (2003), La Porta *et al.* (1999) and Alesina and La Ferrara (2005), countries with high ethno-linguistic fractionalization are expected to exhibit inferior government performance for four reasons. First, high ethnic fractionalization results in pressures for redistribution between groups (Easterly and Levine, 1997). Second, fractionalization may lead to a high demand for publicly-provided private goods, especially those that can be targeted towards specific groups (Alesina *et al.,* 2003). Third, it is also possible that a relationship between fractionalization and corruption is formed, which will result in higher inefficiency. Finally, in more extreme circumstances, increased ethnic fractionalization may lead to ethnic hatred and, ultimately, to violent civil wars that disrupt the workings of government (see Fearon, 2003). Following Easterly and Levine (1997), we control for ethno-linguistic fractionalization using the Herfindahl index, which is calculated on the basis of the share of each separate ethno-linguistic group over total population (data are from La Porta *et al.,* 1999).

To control for the structure of the political system we use two dummy variables. First, we use a dummy that takes the value 1 when the electoral system is considered to be majoritarian, and a value of 0 otherwise. PSE is expected to be higher in countries that use the majoritarian system, as the electoral outcome is generally more sensitive to the incumbent's performance in majoritarian-type elections (Persson and Tabellini, 2003; Persson *et al.,* 2003). Second, we consider whether delegation of power affects PSE. Myerson (1993) and Persson and Tabellini (2003, 2004), suggest that as presidential regimes create a direct link between individual performance and re-appointment in office, the elected officials have strong incentives to perform well, which stimulates public sector performance. The potential impact of the presidential systems on PSE is captured by a dummy variable that takes the value 1 in countries with presidential systems, and 0 in those with parliamentary systems. Information on the majoritarian and presidential variables is from Persson and Tabellini (2004).

Another set of variables illustrates the structure of the elected government. First, we control for the number of ministers who directly use (spend) part of the government budget (i.e. the total number of ministers, excluding the minister of finance). As these ministers are expected to be concerned about the size of the budget they control,[11] the relationship between the number of spending ministers and PSE should be negative. This effect is consistent with the idea that

[11] Ministers care about the size of the budget they receive for many reasons, which may include participation in rent-seeking activities, increase in the size of the bureau they control (Niskanen, 1973) and the ability to make income transfers as a means for controlling a larger political clientele.

diseconomies of scale may be present in the administration of government (see e.g. Stein, 1997). Data for this variable is from Mierau *et al.* (2007). The variable *coalition governments*, which is obtained from Tavares (2004), is a dummy variable, taking the value 1 if a coalition cabinet that includes ministers from two or more parties is in power. As the number of parties involved in the government increases, the accountability of each of the parties usually diminishes, thus providing fewer incentives for efficiency. Also, coalition governments are typically associated with a shorter life span (Schofield, 1993; Müller and Strøm, 2000), and therefore are less concerned with superior performance. Finally, we account for the effect of electoral cycles by including a dummy variable in the empirical analysis, which takes the value of 1 when elections take place that particular year (data is from Tavares, 2004).

Finally, to control for the regulatory environment in the economy we add another dummy variable among the regressors, which takes the value 1 when the country has British legal origin and zero otherwise. Data for this variable is taken from La Porta *et al.* (1998). Studies like that of Djankov *et al.* (2003) suggest that countries with common law (British legal origin) take a more decentralized approach to solving social problems, whereas civil-law countries follow a more regulatory approach. Thus, common-law countries are expected to have less regulations and state intervention in the economy and such elements are usually associated with higher efficiency in providing public goods.

3. Estimation and results

3.1. Estimation method and baseline results

As discussed above, the PSE indicators take values between 0 and 1 (inclusive), with values closer to 1 denoting higher efficiency levels. Therefore, an appropriate econometric specification corresponds to a censored model of the following general form:

$$\begin{array}{ll} pse_{it} = \alpha_0 + \beta_k z_{it} + \lambda_t + u_{it} & \text{if} \quad \widehat{pse}_{it} < 1 \\ pse_{it} = 1 & \text{if} \quad \widehat{pse}_{it} \geq 1 \end{array} \quad , \qquad (3)$$

where λ_t corresponds to time-effects common to all countries, $\widehat{pse}$ are the predicted values of the regression and the rest of the variables are noted as in Eq. (1) above. By construction, the predicted values must be always lower than unity; otherwise they will need to be censored. As in the majority of literature that uses macroeconomic indicators over a large time frame, using time-

effects is crucial to this analysis. In addition, *pse* has both time and cross-sectional (country) dimensions. Thus, panel estimation techniques are used to estimate Eq. (3). Given that we are dealing with a censored regression model, we resort here to the panel-data Tobit methodology with bootstrapped standard errors. As robustness check we also consider (i) the method proposed by Simar and Wilson (2007)[12], (ii) a simple panel data fixed effects model and (iii) a GMM model for dynamic panels.

The baseline results are presented in Tables 3 and 4, where the dependent variables are the PSE education and PSE health indices, respectively. As inefficiency might cause reform over time, all estimated equations include time effects, the results of which are not reported for space constraints reasons. In column 1 of Table 3, the coefficient on the decentralization variable is positive and statistically significant at the 1% level, suggesting a strong positive link between fiscal decentralization and PSE in providing education services. The same is true for the regression of PSE health (see column 1 of Table 4). Therefore, the results of this study are consistent with the part of the theoretical literature that highlights a positive effect of fiscal decentralization on PSE through, for example, enhanced electoral control and yardstick competition among local governments. Although no prior studies on this relationship using macroeconomic data and a direct measure of PSE exist, this result is in line with the findings of Barankay and Lockwood (2007), who use micro data on Swiss cantons.

Following this baseline equation, we examine whether the potential negative effects of decentralization prevail when decentralization levels are high. In other words, we look into the possible non-linearity in the fiscal decentralization-PSE nexus. In column 2 of Tables 3 and 4 we include the squared term of the decentralization variable and we find that the impact of decentralization on PSE is indeed non-linear (inverted U-shaped), as the level and the squared term of the decentralization variable are statistically significant at the 1% level. Notably, this effect remains robust across all specifications in Tables 3 and 4, and thus is irrespective of the variable used to proxy PSE or the inclusion of different control variables in the estimated equations. Intuitively, although the positive forces of fiscal decentralization mentioned above

[12] Simar and Wilson (2007) improve on the econometric inference of models where the dependent variable is obtained from linear programming methods, like DEA. However, their method does not apply to panel data. For the reasons highlighted above, the panel structure of the dataset in this study is maintained by choice and primarily the panel-data Tobit method is used, as it is the conventional one in the literature (Cooper *et al.,* 2004). By using the Simar and Wilson method we have to consider only the cross-sectional dimension of our panel (i.e. we cannot pool the data).

exert a positive impact on PSE, this effect fades out after a certain level of decentralization is reached, probably owing to problems associated with the loss of benefits from economies of scale (Stein, 1997) and the increasing dependence on local officials, who are selected from a lower quality pool of applicants (Prud'homme, 1995).

In fact, the level of fiscal decentralization where its impact on PSE becomes negative, can be calculated using the ratio [(coefficient on decentralization) / (2*coefficient on the squared term of decentralization)]. For the last regression in Table 3, where all the control variables are included, this ratio yields a value of 34.46. This value represents the level of fiscal decentralization that optimizes PSE in the sample of this study, and is found to be very close to the average decentralization values of USA (0.37) and Japan (0.33). The equivalent value for the PSE health (last regression of Table 4) is 47.1, which is closer to the average fiscal decentralization levels of Canada and Sweden. Certainly, these values are related to estimations based on our sample and, thus, should be treated with caution, as they may not be applicable to other groups of countries.

Concerning the remaining explanatory variables, higher GDP per capita is observed to be usually associated with higher PSE in providing education and health services, which is intuitive because rich / productive countries tend to have a more efficient public sector. Population density and the logarithm of population are positive and significant determinants of PSE in both Tables 3 and 4, suggesting that higher economies of scale in the production of public goods benefit PSE education and health. The impact of urban population is insignificant in the PSE education regressions, while it is negative and highly significant in the PSE health regressions. The latter result appears puzzling and a plausible explanation may be that in overpopulated places, the health systems suffer from overcrowded public hospitals and other medical centers, and therefore, diseconomies of scale in the production of services related to health.

Ethno-linguistic fractionalization appears to affect PSE education negatively, indicating that higher population heterogeneity is associated with lower PSE in providing education services. This concurs with prior theoretical studies, as countries with a heterogeneous population resort to higher redistribution among groups and less spending on productive public goods. However, this seems to hold true concerning only the education services, as the fractionalization variable is insignificant in the PSE health equations. This finding may possibly be related to the different

nature of the two services, with ethnic groups having clearly different cultural preferences regarding education services, while requesting homogeneous services in health.

In column (3) of Tables 3 and 4 we additionally control for the structure of the political system, whereas in column (4) we control for the structure of the elected government. Finally, specification (5) includes all the control variables. The results show that PSE is lower in countries with majoritiarian systems and higher in those with presidential systems; however, the effect of these variables is not robust across specifications.[13] Also, the public sectors of countries with a British legal origin are significantly more efficient in providing health and, more importantly, education services. Finally, among the three variables characterizing the structure of the elected government and the time of the elections, only the number of spending ministers is found to be significantly linked to the PSE measures in this study. In particular, a higher number of spending ministers lowers PSE, a result consistent with the idea that diseconomies of scale may be present within the government, leading to diminished government output (see Mierau *et al.,* 2007).

3.2. Sensitivity analysis

In this section we inquire into the robustness of our baseline results. First, the issue of causality is tackled; the central authorities may grant more autonomy to efficient local governments (i.e. more fiscal decentralization). In order to treat this potential problem of reverse causality, we employ an instrumental variables approach. One obvious choice for an instrument is a measure of preference heterogeneity. Higher preference heterogeneity leads to more decentralization (Alesina et al., 2005). On the other hand, preference heterogeneity *per se* is not expected to affect public sector efficiency: voters may have different preferences for the composition of public spending, but will always opt for efficient production by the public sector.

To capture voter preferences heterogeneity we construct two indices, using information from the World Values Survey (WVS). In particular, the WVS asks individuals how much confidence they have in different institutions and organizations. The question is as follows: "I am going to name a number of organizations. For each one, could you tell me how much confidence you have

[13] This lack of robustness can be attributed to the low variability of both variables, as they are both time invariant. Only two countries in the sample have a presidential system, while five countries have a majoritarian system. As columns (2) and (4) of Tables 3 and 4 reveal, the main argument presented in this study remains intact, even when these two variables are not included in the regression.

in them: (i) is it a great deal of confidence, (ii) quite a lot of confidence, (iii) not very much confidence or (iv) none at all?" Here, we focus on the answers given by the respondents about their confidence in two types of institutions, namely (a) Churches (item E069 in the database) and (b) Armed Forces (item E070), and we construct two alternative Herfindahl Concentration Indices:

$$HCI = 1 - \sum_{i=1}^{4} S_i^2 , \qquad (4)$$

where *Si* is the share of group that gave each one of the four alternative answers. We use the two indices as instruments separately, but we also combine them linearly (using their average) as a single instrumental variable characterizing preference heterogeneity. We only report the results from the combined instrument, as the rest are very similar. Since we have both our decentralization variable and its square as endogenous, we also use the squared term of the instrument. In principle, this type of heterogeneity is likely to signal a higher demand for decentralized governments with more local autonomy. In contrast, this variable should not have any direct causal effect on our indices of PSE. In other words, large variance in the beliefs about the confidence in the role of military forces and church are not likely to directly affect public sector's performance in providing health and education services. If anything, the impact of these variables on our PSE indices will be through fiscal decentralization.

We report the results in Table 5. Estimation method is two-stage least squares (2SLS) for panel data with fixed effects and robust standard errors. Some observations drop out compared to previous tables because of the non-availability of our instrumental variable for three countries, namely Greece, Luxembourg and Switzerland. The first-stage results, reported in the upper part of Table 5 show that our instruments are highly significant determinants of fiscal decentralization in both the education and the health equations. The good fit of the instrumental variables is also confirmed by the under-identification and weak identification tests of Anderson (1951) and Kleibergen and Paap (2006), that report rejection of the relevant hypotheses (for more on these issues, see Baum et al., 2007). In both specifications, the coefficients on decentralization and decentralization squared remain statistically significant at the 1% level. Thus, we can conclude that reverse causality does not drive the findings of the main analysis above.

Second, we consider using the decentralization measure of IMF's Government Financial Statistics (GFS), which shows the sub-national revenues as a share of total revenues. The results are reported in column (1) of Tables 6 and 7, for both education and health equations, respectively, and show that the non-linear impact of fiscal decentralization on PSE is true only for the education equation. This probably indicates that using decentralization indicators adjusted for actual tax-raising autonomy (i.e. the results of Stegarescu, 2005) describes the present relationship more accurately.

In columns (2) and (3) of Tables 6 and 7 we exclude in turn the Mediterranean and Scandinavian countries from our sample. In both the PSE education and PSE health equations, the relationship between fiscal decentralization and PSE remains an inverted U-shaped one, showing that our main result is not sensitive to the effect of specific regions.

In equation (4) of Tables 5 and 6, we investigate whether corruption is the element captured by our PSE indicators that primarily drives our results. Although PSE involves many types of non-productive spending (e.g. personnel expansion, inefficient bureaucratic organization etc.) it may also include actual corruption. Then, it may be argued that the effect of decentralization on PSE is driven by the effect of fiscal decentralization on corruption. We examine this hypothesis by running a simple OLS regression of PSE on corruption and using the residuals as our dependent variable.[14] The results remain practically unchanged, showing that the PSE indicator in this study is a broader measure that encompasses additional elements of public sector inefficiency that may include (but are not limited to) personnel expansion (Williamson, 1964), lower effort (Wyckoff, 1990) and excessive risk aversion (Peltzman, 1973).[15]

In the remaining equations presented in columns (5)-(6) we examine whether our results are driven by the econometric method used. In column (5) we present the results obtained from a simple panel data fixed effects model and we observe that the non-linear relationship remains unaffected. The same is true when we estimate our empirical model using the method of Simar and Wilson (2007).[16] Although this method treats all observations as cross-sections, the estimated coefficients and their significance are very similar to those reported in column (5) of Tables 3 and 4 (i.e. the equivalent equations estimated with the Tobit method).

[14] To capture corruption we employ data from the International Country Risk Guide (2009) database.
[15] For a comprehensive review, see Wintrobe (1997).
[16] These regressions are carried out using Algorithm 2, as done by Simar and Wilson (2007, pp. 42-43). To obtain bootstrap estimates we follow the suggestion of Simar and Wilson in using 100 replications. Finally, bootstrap standard errors (needed to calculate t-statistics) are estimated using 1000 replications.

4. Conclusions

In this paper we specify an empirical framework to investigate the effect of fiscal decentralization on public sector efficiency (PSE). With this aim we (i) directly measure PSE at the country-level by specifying an underlying production process of public goods; and (ii) use the new indices and well-established measures of fiscal decentralization to examine their nexus. The analysis is carried out on a panel comprising 21 OECD economies for the period 1970-2000. Backed by strong empirical results, obtained from several different specifications and sensitivity analyses, we contend that public sector efficiency and fiscal decentralization are related in an inverted U-shaped way. Therefore, higher fiscal decentralization is beneficial for the efficiency of OECD public sectors in providing education and health services; however, if it rises too high further decentralization of the public sector is detrimental for PSE.

This is a new result and may possibly explain the many differences in the findings of previous empirical literature that uses either micro data or indirect measures of efficiency to characterize the current relationship. Policy implications are straightforward. Countries with relatively low levels of fiscal decentralization will benefit from transferring part of their powers to local governments. However, countries that already have a highly decentralized fiscal system may want to consider reducing the powers of local governments, especially if they face diseconomies of scale and / or increased pressure from local interest groups owing to decentralization. Clearly, these findings and policy implications call for a deeper understanding of the inter- and intra-country mechanisms that create the non-linear pattern and this definitely warrants future research.

Appendix A. Public sector efficiency indicators: Formulation and sources

To measure public sector efficiency we follow the rationale of the methodology developed by Afonso *et al*. (2005). The basic insight of this methodology is to compare the performance of government in certain areas of economic activity with the associated expenditures that the government allocates to achieve this particular performance. Therefore, to construct a PSE index the following data are required: (i) some measure capturing Public Sector Performance (PSP) that serves as the output, and (ii) some measure of the associated Public Sector Expenditure (PEX) that serves as input. The performance (PSP) and expenditure measures (PEX) used to construct the *PSE* indicators for each policy area are described in Table B1 and the summary statistics are provided in Table B2 below.

Table A1: Public sector efficiency indicators

Policy area	**Performance measure (PSP)**	**Expenditure measure (PEX)**
Education	Years of Schooling (Barro and Lee, 2001) multiplied by the quality of education index *cognitive* developed by Hanushek and Woessmann (2009).	Public spending in education (taken from Busemeyer (2007))
Health	Inverse of the infant mortality rate (taken from OECD Health Data ,2007)	Public spending in Health (taken from OECD Health Data, 2007)

Table A2: Summary statistics for outputs (PSP) and inputs (PEX)

Outputs	Mean	Std.Dev.	Min	Max
Years of Schooling	8.27	1.901	2.6	12.05
Quality of education index *cognitive*	4.95	0.185	4.5	5.3
Infant mortality rate at birth	10.45	6.308	3.2	55.5
Ratio of public to total spending on Education	0.89	0.073	0.75	1.00
Ratio of public to total spending on Health	0.73	0.124	0.41	0.91
Inputs				
Public spending on education (% of GDP)	5.49	1.19	1.8	10.2
Public spending on health (% of GDP)	5.31	1.48	1.0	8.0

Appendix B. Data definitions and sources

Variable	Description	Sources
PSE education	DEA efficiency scores with public spending on education as input (obtained from) and the product of years of schooling and education quality as output	Own estimations based on the methodology described in Section 2.1
PSE health	DEA efficiency scores with public spending on health as input and the reverse of infant mortality as output	Own estimations based on the methodology described in Section 2.1
Decentralization: taxrevdec	Sub-central government own tax revenue as a share of general government total tax revenue.	Stegarescu (2005)
Decentralization: decindex	Sub-central government Expenditure as a share of total expenditures	Government Financial Statistics, IMF (2002)
GDP per capita	GDP per capita (constant 2000 US dollars)	World Development Indicators (2004)
Population density	Number of people per square klm	World Development Indicators (2004)
Urban population	Share of urban population to total population	World Development Indicators (2004)
Log of population	Logarithm of total population	World Development Indicators (2004)
Ethno-linguistic fractionalization	Index of ethno-linguistic fractionalization	La Porta et al. (1999)
Majoritarian systems	Dummy variable taking the value 1 when the electoral system is majoritarian and 0 otherwise	Persson and Tabellini (2003)
Presidential systems	Dummy variable taking the value 1 when the political system is presidential and 0 otherwise	Persson and Tabellini (2003)
British legal origin	Dummy variable taking the value 1 when the country has British legal origin and 0 otherwise	La Porta et al. (1998)
Number of spending ministers	Number of Spending Ministers	Mierau et al. (2007)
Coalition government	Dummy variable taking the value 1 if a coalition cabinet is in power	Tavares (2004)
Electoral cycle	Dummy variable taking the value 1 when elections take place at that year and 0 otherwise	Tavares (2004)
Preferences Heterogeneity	Herfindahl Concentration Indices (for more details see Section3.2)	World Values Survey (2000)

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Table 1
Summary statistics

Variable	Obs.	Mean	Std. dev.	Min.	Max.
PSE education	492	0.626	0.216	0.195	1.000
PSE health	597	0.645	0.222	0.250	1.000
decentralization: taxrevdec	522	0.224	0.171	0.003	0.615
decentralization: decindex	481	31.709	13.768	1.450	59.180
GDP per capita	650	9.727	0.423	8.317	10.709
population density	620	1.291	1.188	0.016	4.699
urban population	651	73.536	13.703	25.910	97.340
log of population	609	16.518	1.431	12.736	19.414
ethno-linguistic fractionalization	651	0.131	0.113	0.003	0.376
coalition governments	633	15.310	4.791	5.000	33.000
fractionalization	348	0.691	0.036	0.581	0.742

Note: The table presents the number of observations and summary statistics (mean, standard deviation, minimum and maximum) of the variables used in the empirical analysis (excluding the dummy variables).

Table 2
Correlation matrix

	PSE educ.	PSE health	dec. (taxrevdec.)	dec. (decindex)	GDP per capita	popul. density	urban popul.	log of popul.	ethno-ling. fract.	major. syst.	presid. syst.	British legal origin	no. spend. minist.	coal. gov.	elect. cycle
PSE education	1.000														
PSE health	0.047	1.000													
decentralization (taxrevdec)	0.202	0.290	1.000												
decentralization (decindex)	0.200	0.436	0.718	1.000											
GDP per capita	0.297	0.179	0.557	0.342	1.000										
population density	-0.152	-0.125	-0.504	-0.444	-0.114	1.000									
urban population	0.357	-0.285	-0.002	0.041	0.206	0.503	1.000								
log of population	0.353	0.019	0.029	0.166	0.086	0.173	0.372	1.000							
ethno-linguistic fractionalization	0.153	0.101	0.526	0.270	0.205	-0.033	0.202	0.203	1.000						
majoritarian systems	0.421	0.060	0.232	0.227	0.014	-0.232	0.266	0.458	0.378	1.000					
presidential systems	0.310	0.600	0.435	0.307	0.482	-0.100	-0.141	0.393	0.337	0.200	1.000				
British legal origin	0.437	0.110	0.159	0.327	-0.119	-0.276	0.105	0.375	0.318	0.743	0.206	1.000			
number of spending ministers	-0.149	-0.435	0.081	0.038	-0.053	-0.146	0.190	0.227	0.072	0.345	-0.420	0.103	1.000		
coalition governments	-0.192	0.036	-0.253	-0.194	-0.018	0.311	0.013	-0.301	-0.116	-0.476	-0.139	-0.443	-0.250	1.000	
electoral cycle	0.047	0.077	0.033	0.053	-0.006	-0.062	-0.003	0.054	0.018	0.060	0.071	0.072	0.018	-0.087	1.000

Table 3
Public sector efficiency in providing education services and fiscal decentralization

	(1)	(2)	(3)	(4)	(5)
GDP per capita	0.319***	0.310***	0.345***	0.246***	0.357***
	(12.587)	(11.441	(8.734)	(5.782)	(8.374)
population density	0.004	0.014***	0.038***	0.009	0.030***
	(0.768)	(2.591)	(6.171)	(1.49	(5.154)
urban population	0.000	-0.001**	-0.001	0.001	-0.001
	(0.115)	(-2.078)	(-1.264)	(1.367)	(-1.597)
log of population	0.051***	0.048***	0.025***	0.056***	0.048***
	(10.694)	(9.550)	(6.479)	(6.413)	(5.590)
ethno-linguistic fractionalization	-0.078	0.044	-0.163***	0.036	-0.073
	(-1.590)	(1.021)	(-5.803)	(0.662)	(-1.388)
decentralization (taxrevdec)	0.148***	0.691***	0.838***	0.904***	0.965***
	(3.537)	(6.631)	(10.047)	(6.366)	(10.597)
decentralization squared (taxrevdec)		-0.010***	-0.013***	-0.014***	-0.014***
		(-5.334)	(-10.384)	(-6.429)	(-10.079)
majoritarian systems			-0.049***		-0.035***
			(-3.540)		(-2.653)
presidential systems			0.087*		-0.072
			(1.924)		(-1.098)
British legal origin			0.186***		0.186***
			(11.771)		(14.851)
number of spending ministers				-0.014***	-0.013***
				(-5.171)	(-3.617)
coalition governments				-0.022	0.020
				(-1.061)	(0.987)
electoral cycle				0.001	0.001
				(0.035)	(0.067)
constant term	-3.368***	-3.203***	-3.250***	-2.627***	-3.551***
	(-16.531)	(-14.588)	(-10.125)	(-8.562)	(-10.366)
observations	390	390	390	390	390
censored observations	48	48	48	48	48
Wald test	2848.459	3167.458	9687.954	2487.518	6662.182
p-value of Wald test	0.000	0.000	0.000	0.000	0.000

Note: *, **, *** denote statistical significance at 10%, 5% and 1% level of statistical significance respectively. The Wald test and the associated p-value reflect the joint significance of the coefficients. All equations are estimated using a panel data Tobit method.

Table 4
Public sector efficiency in providing health services and fiscal decentralization

	(1)	(2)	(3)	(4)	(5)
GDP per capita	0.147***	0.128***	-0.052*	0.077***	-0.027
	(6.962)	(5.789)	(-1.659)	(2.779)	(-0.895)
population density	0.079***	0.094***	0.094***	0.078***	0.090***
	(15.742)	(17.347)	(13.386)	(12.094)	(12.228)
urban population	-0.012***	-0.013***	-0.009***	-0.011***	-0.009***
	(-17.033)	(-19.701)	(-10.155)	(-16.606)	(-8.957)
log of population	0.063***	0.061***	0.020***	0.076***	0.036***
	(13.560)	(13.013)	(2.712)	(17.128)	(3.798)
ethno-linguistic fractionalization	-0.268***	-0.109	-0.345***	-0.185*	-0.321***
	(-3.088)	(-1.252)	(-5.301)	(-1.957)	(-4.107)
decentralization (taxrevdec)	0.812***	1.781***	1.885***	1.790***	1.884***
	(11.677)	(10.152)	(15.275)	(10.077)	(13.153)
decentralization squared (taxrevdec)		-0.019***	-0.022***	-0.017***	-0.020***
		(-6.182)	(-8.856)	(-5.449)	(-7.648)
majoritarian systems			-0.072***		-0.042
			(-2.583)		(-1.363)
presidential systems			0.587***		0.447*
			(2.607)		(1.728)
British legal origin			0.076**		0.062**
			(2.250)		(1.990)
number of spending ministers				-0.025***	-0.012***
				(-10.772)	(-3.873)
coalition governments				-0.007	0.004
				(-0.373)	(0.255)
electoral cycle				0.028*	0.013
				(1.959)	(0.849)
constant term	-1.175***	-0.940***	1.143***	-0.465*	0.848***
	(-6.174)	(-4.849)	(4.211)	(-1.870)	(3.103)
observations	451	451	451	450	450
censored observations	85	85	85	85	85
Wald test	1783.863	1622.352	3828.872	1430.233	5415.059
p-value of Wald test	0.000	0.000	0.000	0.000	0.000

Note: *, **, *** denote statistical significance at 10%, 5% and 1% level of statistical significance respectively. The Wald test and the associated p-value reflect the joint significance of the coefficients. All equations are estimated using a panel data Tobit method.

Table 5
Public sector efficiency and fiscal decentralization: 2SLS regressions

	(1)	(2)
Dependent variable	Efficiency in education	Efficiency in health
First-stage results		
Preference heterogeneity	13.930***	10.263**
	(2.820)	(2.570)
Preference heterogeneity squared	-12.910***	-9.769***
	(-3.371)	(-3.138)
Second-stage results		
GDP per capita	0.196**	-0.264***
	(2.504)	(-3.217)
population density	-0.013	0.127***
	(-0.609)	(8.380)
urban population	0.001	-0.013***
	(0.557)	(-10.785)
log of population	0.122***	0.032***
	(5.838)	(3.048)
ethno-linguistic fractionalization	0.306	-0.196
	(1.293)	(-1.550)
decentralization (taxrevdec)	3.842***	3.793***
	(7.074)	(7.655)
decentralization squared (taxrevdec)	-7.075***	-5.367***
	(-5.906)	(-6.830)
majoritarian systems	-0.270***	-0.032
	(-3.363)	(-0.959)
presidential systems	-0.493***	0.144***
	(-7.073)	(2.741)
British legal origin	0.385***	0.176***
	(9.970)	(5.166)
number of spending ministers	-0.015***	-0.014***
	(-2.650)	(-3.214)
coalition governments	-0.020	0.019
	(-0.611)	(0.746)
electoral cycle	0.006	0.005
	(0.289)	(0.305)
observations	223	292
R-squared	0.608	0.555
Under-identification test	26.216	30.868
(p-value)	(0.000)	(0.000)
Weak identification test	14.711	37.469

Note: *, **, *** denote statistical significance at 10%, 5% and 1% level of statistical significance respectively. We report an under-identification test and its p-value, which is the Anderson's (1951) canonical correlation test; we also report the weak identification test of Kleibergen and Paap (2006). Both equations are estimated using two-stage least squares (2SLS) with fixed effects and robust standard errors.

Table 6
Public sector efficiency in providing education services and fiscal decentralization: Sensitivity analysis

	(1)	(2)	(3)	(4)	(5)	(6)
GDP per capita	-0.052	0.530***	0.030	0.399***	0.380***	0.421***
	(-0.615)	(7.387)	(0.562)	(6.917)	(8.731)	(7.140)
population density	-0.000	0.020***	-0.011	0.037***	0.022**	0.031***
	(-0.007)	(2.922)	(-1.435)	(5.080)	(2.152)	(3.842)
urban population	0.005***	-0.000	0.003***	-0.006***	-0.001	-0.003**
	(4.628)	(-0.262)	(3.435)	(-6.168)	(-0.982)	(-2.515)
log of population	-0.01	0.047***	0.139***	0.074***	0.045***	0.051***
	(-1.206)	(5.095)	(14.956)	(4.579)	(4.030)	(6.042)
ethno-linguistic fractionalization	0.015	0.023	-0.065	0.017	-0.045	-0.084
	(0.182)	(0.308)	(-0.751)	(0.126)	(-0.423)	(-1.604)
decentralization (decindex)	1.430***					
	(4.529)					
decentralization squared (decindex)	-0.022***					
	(-4.293)					
decentralization (taxrevdec)		0.873***	2.139***	1.461***	0.744***	0.714***
		(9.261)	(12.314)	(8.937)	(3.398)	(7.003)
decentralization squared (taxrevdec)		-0.014***	-0.036***	-0.023***	-0.011***	-0.011***
		(-9.141)	(-12.338)	(-10.026)	(-3.079)	(-5.082)
majoritarian systems	0.064**	-0.060***	-0.194***	-0.033	-0.031	-0.033***
	(2.574)	(-4.752)	(-8.397)	(-0.837)	(-0.906)	(-2.603)
presidential systems	0.250***	-0.134	-0.276***	-0.348***	-0.088*	-0.065
	(2.808)	(-1.644)	(-5.043)	(-4.390)	(-1.835)	(-0.902)
British legal origin	0.065**	0.243***	0.294***	0.269***	0.182***	0.180***
	(2.116)	(13.017)	(12.449)	(12.210)	(7.150)	(9.865)
number of spending ministers	-0.005*	-0.014***	-0.007*	-0.031***	-0.013***	-0.016***
	(-1.659)	(-3.292)	(-1.857)	(-7.329)	(-4.711)	(-5.840)
coalition governments	-0.020	0.037*	0.080***	-0.052*	0.019	-0.034
	(-0.960)	(1.748)	(4.168)	(-1.742)	(1.030)	(-1.403)
electoral cycle	-0.002	-0.001	0.016	0.002	0.002	0.002
	(-0.073)	(-0.065)	(1.032)	(0.064)	(0.114)	(0.174)
constant term	0.744	-5.284***	-2.393***	-4.459***	-3.708***	-2.800***
	(0.906)	(-7.750)	(-5.798)	(-8.135)	(-8.875)	(-4.901)
observations	345	371	288	199	390	390
censored observations	30	48	31			48
Wald test	1363.599	2360.372	6547.596	6883.492		
p-value of Wald test	0.000	0.000	0.000	0.000		

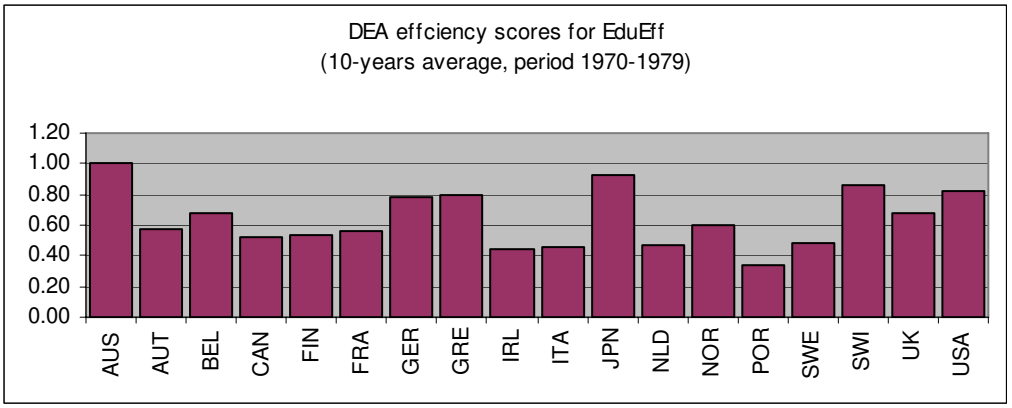
Note: *, **, *** denote statistical significance at 10%, 5% and 1% level of statistical significance respectively. The Wald test and the associated p-value reflect the joint significance of the coefficients. Equations (1)-(3) are estimated using a panel data Tobit method, equation (4) using a fixed effects panel data model, equation (5) using a panel data random effects model and equation (6) using the Simar and Wilson (2007) method. In equation (2) we exclude the Mediterranean countries from the sample and in equation (3) we exclude Scandinavian countries.

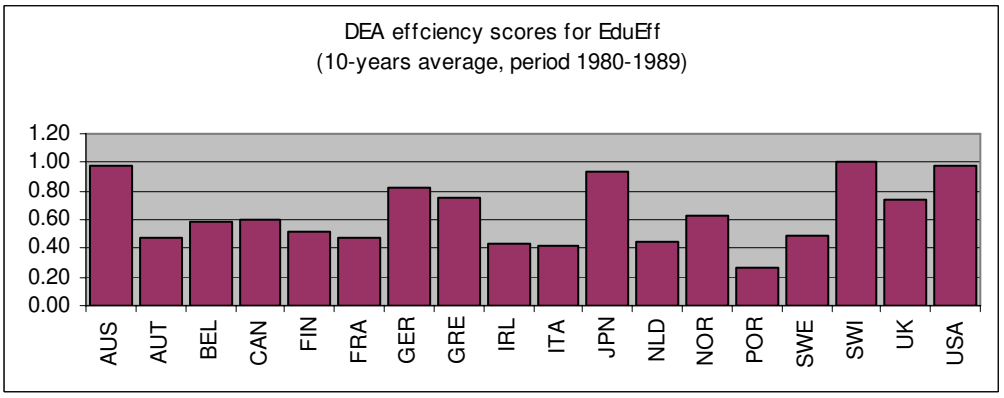
Table 7
Public sector efficiency in providing health services and fiscal decentralization: Sensitivity analysis

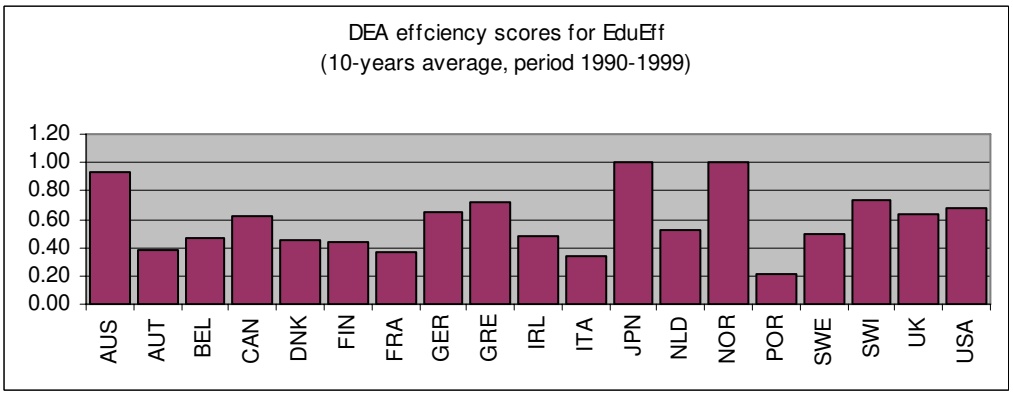
	(1)	(2)	(3)	(4)	(5)	(6)
GDP per capita	-0.117**	0.000	0.153***	-0.093	-0.115***	0.161***
	(-2.313)	(0.003)	(2.759)	(-1.059)	(-2.745)	(2.914)
population density	-0.006	0.120***	0.080***	0.031**	0.074***	0.083***
	(-0.442)	(11.670)	(8.084)	(2.170)	(7.564)	(8.560)
urban population	-0.001	-0.011***	-0.010***	-0.011***	-0.007***	-0.007***
	(-0.520)	(-11.557)	(-9.150)	(-6.635)	(-7.540)	(-6.452)
log of population	-0.046***	0.010	-0.043**	0.177***	0.025**	0.061***
	(-3.705)	(0.760)	(-1.968)	(7.966)	(2.438)	(5.322)
ethno-linguistic fractionalization	-0.247***	-0.560***	-0.456***	0.331*	-0.355***	-0.363***
	(-2.771)	(-5.054)	(-5.629)	(1.908	(-3.701)	(-4.504)
decentralization (decindex)	-0.691*					
	(-1.873)					
decentralization squared (decindex)	0.015**					
	(2.364)					
decentralization (taxrevdec)		1.945***	2.148***	2.698***	1.828***	1.047***
		(14.156)	(9.662)	(8.889)	(8.617)	(4.753)
decentralization squared (taxrevdec)		-0.018***	-0.029***	-0.034***	-0.021***	-0.016***
		(-6.092)	(-8.123)	(-7.398)	(-5.789)	(-3.255)
majoritarian systems	0.088*	0.052	0.012	-0.380***	-0.027	0.011
	(1.845)	(1.410)	(0.306)	(-4.982)	(-0.838)	(0.281)
presidential systems	0.795***	0.483*	0.512*	-0.418***	0.230***	0.608***
	(3.149)	(1.724)	(1.736)	(-5.521)	(4.694)	(2.715)
British legal origin	-0.067**	0.073**	-0.038	0.056	0.058**	0.068**
	(-2.439)	(2.210)	(-0.735)	(1.526)	(2.127)	(2.122)
number of spending ministers	-0.009***	-0.012***	-0.011***	-0.028***	-0.010***	-0.017***
	(-4.240)	(-3.398)	(-4.573)	(-7.341)	(-3.534)	(-4.159)
coalition governments	0.009	0.053***	-0.067***	-0.042	0.003	0.001
	(0.374)	(2.582)	(-2.725)	(-1.015)	(0.192)	(0.092)
electoral cycle	0.006	0.018	0.018	0.008	0.01	0.022
	(0.513)	(1.121)	(0.857)	(0.272)	(0.624)	(1.257)
constant	2.769***	1.059**	0.56	-0.977	1.731***	-0.251
	(4.731)	(2.003)	(1.551)	(-1.051)	(4.164)	(-1.042)
observations	389	407	330	262	450	450
censored observations	50	85	66			85
Wald test	289.147	4110.817	1255.415	4531.276		
p-value of Wald test	0.000	0.000	0.000	0.000		

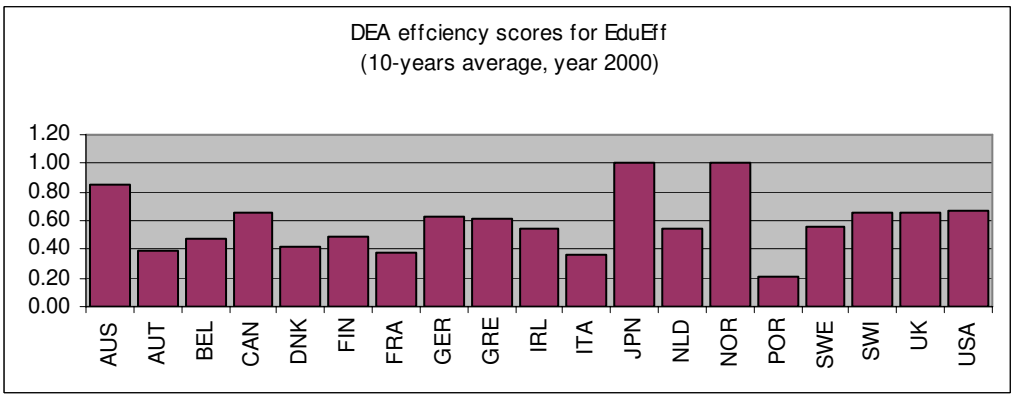
Note: *, **, *** denote statistical significance at 10%, 5% and 1% level of statistical significance respectively. The Wald test and the associated p-value reflect the joint significance of the coefficients. Equations (1)-(3) are estimated using a Tobit model, equation (4) using a fixed effects panel data model, equation (4) using a panel data random effects model and equation (6) using the Simar and Wilson (2007) method. In equation (2) we exclude the Mediterranean countries from the sample and in equation (3) we exclude Scandinavian countries.

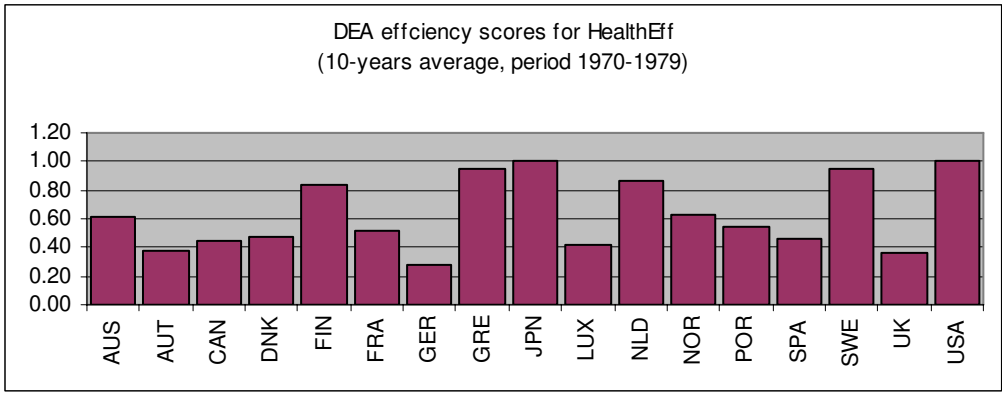
Figure 1
PSE in providing education (EduEff) and health (HealthEff) services










DEA effciency scores for HealthEff
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0.80
0.60
0.40
0.20
0.00
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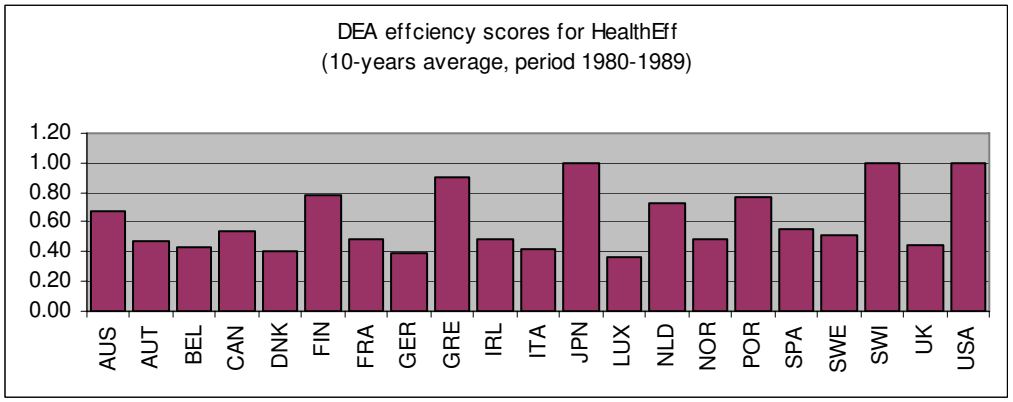
CAN
DNK
FIN
FRA
GER
GRE
JPN
LUX
NLD
NOR
POR
SPA
SWE
UK
USA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0.40
0.20
0.00
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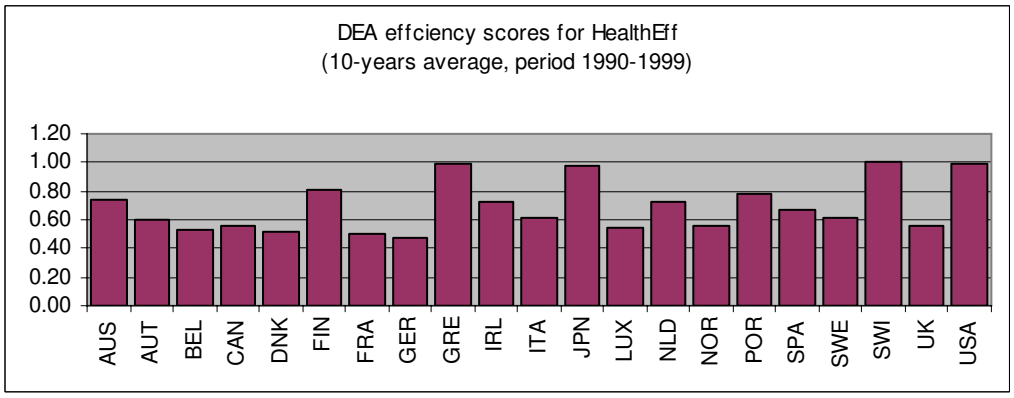
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0.40
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AUT
BEL
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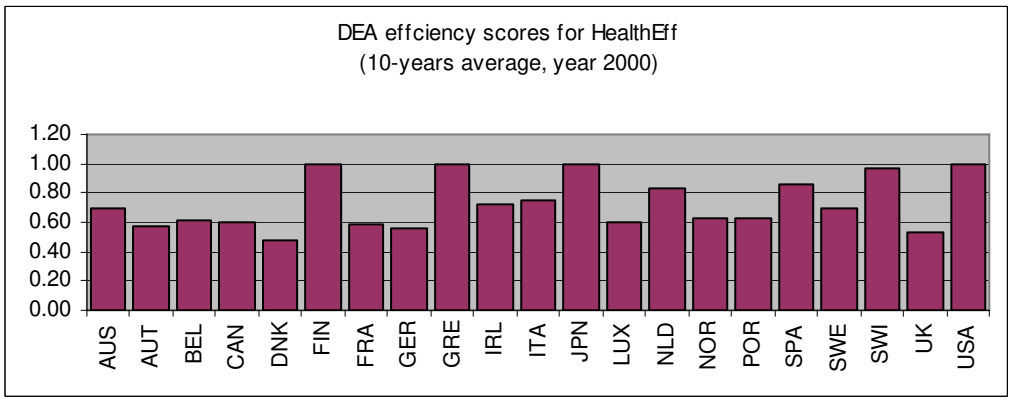
DEA effciency scores for HealthEff
(10-years average, year 2000)
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1.00
0.80
0.60
0.40
0.20
0.00
AUS
AUT
BEL
CAN
DNK
FIN
FRA
GER
GRE
IRL
ITA
JPN
LUX
NLD
NOR
POR
SPA
SWE
SWI
UK
USA