School of Economics and Management
TECHNICAL UNIVERSITY OF LISBON

Department of Economics

António Afonso, Alma Romero & Emma Monsalve

Public sector efficiency: evidence for Latin America

WP 20/2013/DE/UECE

WORKING PAPERS

ISSN Nº 0874-4548

.

Public sector efficiency: evidence for Latin America [*]

António Afonso, [$] Alma Romero,[#] and Emma Monsalve [#]

May 2013

Abstract

We compute Public Sector Performance (PSP) and Public Sector Efficiency (PSE) indicators and Data Envelopment Analysis (DEA) efficiency scores for a sample of twenty-three Latin American and Caribbean Countries (LAC) to measure efficiency of public spending for the period 2001-2010. Our results show that the PSE is inversely correlated with the size of the government, while the efficiency frontier is essentially defined by Chile, Guatemala, and Peru. Moreover, on average, output quantities could theoretically be proportionally increased by 19 percent with the same level of inputs. In addition, the performed Tobit analysis suggests that more transparency and regulatory quality improve the efficiency scores, while more transparency and control of corruption increase output-oriented efficiency.

JEL Classification: C14, C61, H50, N16, O54.
Keywords: public sector performance, technical efficiency, Tobit, DEA, Latin America, Caribbean.

[*] The opinions expressed herein are those of the authors and do not necessarily reflect the views of the Inter-American Development Bank, its Board of Directors, or the countries they represent, nor the views of the ECB or the Eurosystem.

[$] ISEG/TULisbon – Technical University of Lisbon, School of Economics and Management, Department of Economics; UECE – Research Unit on Complexity and Economics, R. Miguel Lupi 20, 1249-078 Lisbon, Portugal, email: aafonso@iseg.utl.pt. UECE is supported by Fundacão para a Ciência e a Tecnologia (Portuguese Foundation for Science and Technology) through the project PEst-OE/EGE/UI0436/2011. European Central Bank, Directorate General Economics, Kaiserstraße 29, D-60311 Frankfurt am Main, Germany.
[#] Inter-American Development Bank, 1300 New York Avenue Northwest Washington, DC 20577, USA, emails: almar@iadb.org; emmamo@iadb.org.

.

Contents

.

1. Introduction

The optimal size of public spending is a difficult issue to address both empirically and theoretically. In practice, however, policymakers must decide period by period on the level of public expenditure to be exerted in order to maximize social welfare (assuming governments are benevolent). Expenditure levels greatly vary from country to country and the effect of additional spending on marginal welfare gains is still open for debate. Notwithstanding, the literature has provided over the years evidence in support to the idea that above certain threshold, benefits from larger public spending, measured by improvements in key social and economic indicators, tend to decline.

In early works Tanzi and Schuknecht (1997, 2000) used a macro approach to identify a relationship between higher public spending and higher social welfare in a sample of eighteen industrialized economies. The authors did not find evidence of higher benefits in countries with higher public spending given that countries with lower levels of public spending had socio-economic indicators as good as their counterparts, if not better. In more recent contributions, Afonso, Schuknecht, and Tanzi (2005, 2010a) assess the outcome of public policies and its relationship to the resources employed to measure government performance and efficiency through the concepts of Public Sector Performance (PSP) and Public Sector Efficiency (PSE) initially applied to a sample of twenty-three industrialized OCDE countries and later on extended to a group of developed economies. Their overall conclusion is that small governments obtain better indicators than big governments and that lean public sectors tend to be more efficient.

The renovated interest of academics, policy makers, and international organizations on the analysis and quantification of the efficiency of public spending at the aggregate level has been recently motivated by the current challenging global conditions. The adverse position often faced by governments (increasing budgetary pressures and narrowing margins of action to significantly raise tax revenue) and the costly consequences of fiscal imbalances prompted by excessive accumulation of government debt to finance high spending levels, experienced by a handful of countries in recent past decades, has turned the attention to the ability of governments to achieve public policy outcomes employing the least possible amount of resources more relevant in recent times.[1] Unfortunately, the literature on aggregate public sector efficiency is not

[1] In a numerical exercise with a calibrated model, Afonso and Gaspar (2007) find that indirect costs, associated with excess burden, amplify the cost of inefficiency by between 20 percent and 30 percent.

.

abundant and international comparisons of government performance are largely scarce due to data unavailability, limiting the analysis of the empirics of the optimality of public spending.

This paper contributes to the literature by extending the analysis of Afonso et al. (2005, 2010a), based on the computation of the Public Sector Performance (PSP) and Public Sector Efficiency (PSE) indicators and Data Envelopment Analysis (DEA), applied to a sample of twenty-three Latin American and Caribbean Countries (LAC) to measure efficiency of public spending for the period 2001-2010. We also assess the relevance of non-discretionary factors for public sector efficiency via censored Tobit regressions.

To the best of our knowledge this is the first attempt in the literature to quantify government performance and efficiency in the Latin American region. Our results show that the size of the government is inversely correlated with efficiency scores, while the efficiency frontier is essentially defined by Chile, Guatemala, and Peru. Moreover, on average, output quantities could theoretically be proportionally increased by 19 percent with the same level of inputs. Additionally, a Tobit analysis shows that more transparency and regulatory quality improve the efficiency scores, while further transparency and control of corruption increase output-oriented efficiency.

The remainder of the paper is organized as follows. Section two reviews the related literature. Section three presents the methodology. Section four reports and discusses our dataset, and empirical results. Section five concludes.

2. Related literature

Public sector efficiency analysis has its precedent on the literature quantifying productive efficiency of firms or decision making units of diverse nature. For instance, Cherchye and Post (2001) address efficiency of electricity generating plants, Burgess and Wilson (1998) of hospitals, and Wheelock and Wilson (2003) of banking institutions. Afonso and Santos (2008) assess efficiency of Portuguese Universities and St. Aubyn et al. (2009) of Universities in the European Union. Other examples are Eugène (2008) for the relative efficiency of Belgian general government as provider of public order and safety, in addition to health care and education services, while St. Aubyn (2008) offers a review of the literature on law and order (police, prison and judicial systems) efficiency measurement and Afonso et al. (201b) assess the efficiency of public spending in redistributing income.

.

In the case of public sector performance, the vast majority of the related literature has centered the analysis of public spending efficiency in health and education across countries. Gupta and Verhoeven (2001) measure the efficiency of government expenditure on education and health in a group of African countries employing the Free Disposable Hull (FDH) method. Herrera and Pang (2005) quantify efficiency in both sectors using a panel of 160 countries employing the FDH and the Data Envelopment Analysis (DEA). Afonso and Aubyn (2005, 2006) assess efficiency of spending in education and health in OCDE countries utilizing both FDH and DEA and extend their analysis by using bootstrap methods in subsequent works (Afonso, and St. Aubyn, 2006a, b, 2011). Other contributions to the assessment of education spending efficiency are provided by Clements (2002) for the European Union, and St. Aubyn (2003) and Sutherland, Price, Joumard, and Nicq (2007) for OCDE countries. Efficiency of the health sector is addressed by Evans, Tandon, Murray and Lauer (2000), and Joumard, Hoeller, André, Nicq (2010).

A smaller strand of the literature has focused on the analysis of efficiency of public expenditure at the subnational or aggregate level. Notable examples are Van den Eeckhaut, Tulkens and Jamar (1993) for the assessment of efficiency of public spending in Belgian municipalities, De Borger and Kerstens (1996) for Belgian local governments, Afonso and Fernandes (2006, 2008) for Portuguese municipalities, Afonso and Scaglioni (2007) for Italian regions, and Geys, Heinemann, and Kalb (2010) for German municipalities. There are, however, fewer contributions to the analysis of aggregate public sector spending efficiency, with the notable exception of Afonso et al. (2005, 2010a).

3. Methodology

3.1. Public sector performance

Nonparametric methods, particularly the Data Envelopment Analysis, and the Free Disposal Hull in earlier works, have become the predominant approach to assess relative efficiency of public spending across countries and within sectors. The DEA methodology developed by Farrell (1957) can be used to determine efficiency by comparing actual spending with the minimum necessary spending to produce the same outcome (input approach). Such a minimum is defined by the efficiency frontier computed from sample data using linear programming methods assuming convexity of the production set. Alternatively, relative

.

efficiency can be defined by determining the highest possible level of output to be produced for a given level of spending (output-oriented approach). A similar analysis can be conducted employing the Free Disposable Hull (FDH) methodology proposed by Deprins, Simar, and Tulkens (1984) which assumes free-disposability of resources in the production process. Limitations of both methods, sensitivity to sample variability, presence of outliers, and the quality of data in the case of the DEA, and the overestimation of efficient decision making units in the case of the FDH (Herrera and Pang, 2005) make desirable a complementary approach. Due to that, we employ the concept of PSP to measure government performance in LAC for 2001-2010 and quantify the efficiency of such public sector activities computing PSE and DEA scores using total public spending-to-GDP ratios as input and PSP scores as output.

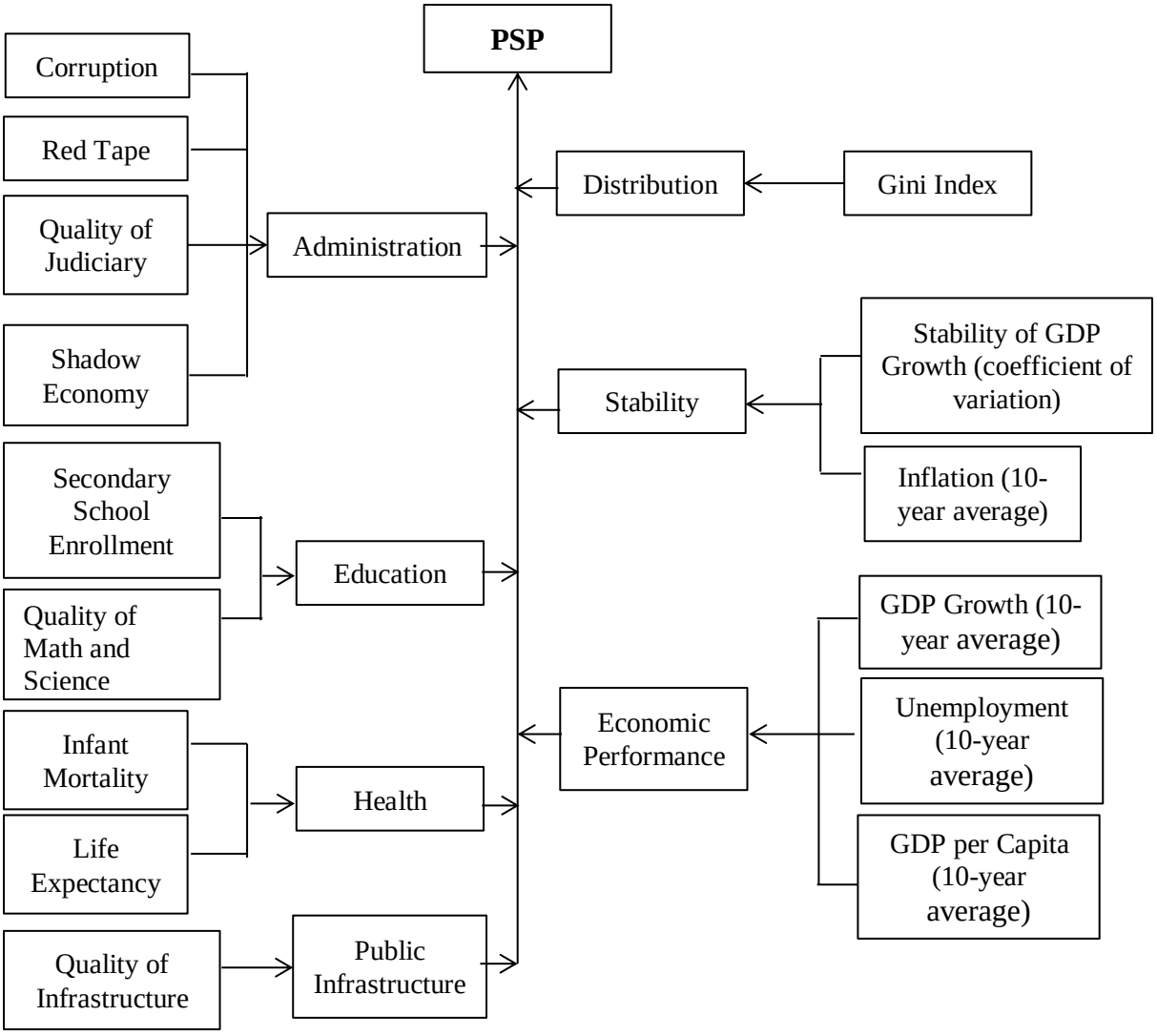
Public sector performance as defined by Afonso, Schuknecht, and Tanzi (AST from now on) is assessed by constructing composite indicators based on observable socio-economic variables that are assumed to be the output of pursued public policies. Specifically, the PSP for country $i = 1, \dots, m$ with $j = 1, \dots, n$ areas of government activity is determined by:

$$PSP_i = \sum_{j=1}^{n} w_j PSP_{ij}; \sum_{j=1}^{n} w_j = 1; \ \ with\, PSP_{ij} = f(I_k), k = 1, \dots, r. \qquad (1)$$

where w_j is the weight applied to the j[th] government activity and $f(I_k)$ is a function of k observable socio-economic indicators. Following AST seminal work we use two groups of indicators to define the PSP composite indicator as Figure 1 shows.

.

Figure 1 – Public Sector Performance Indicator (PSP)



The first group comprises outcomes derived from government activities as public administrator as well as provider of public services such as education, health and infrastructure. AST refer to this subset of indicators as "opportunity" indicators alluding to the role of the government as promoter of equal opportunities in the market place.

The second group is composed of outcome indicators of government activities in terms of allocation, distribution, and stabilization functions as defined by Musgrave. Each group of indicators includes sub-indicators determined by the average value of the corresponding output variables. For instance, government performance as public administrator is defined by the

.

average value of outcome indicators for corruption, burden of regulation (red tape), independence of the judiciary system, and the size of the informal economy. The rationale behind these indicators is the application of the rule of law, enforcement of contracts, defense of property rights and operability of well-functioning markets promoted by the state.

The performance of the government as supplier of public goods and services is limited to the provision of education, health, and public infrastructure. As for education we focus on indicators of the quality of education (specifically on math and science) and secondary school enrolment rates. For health we consider the traditional output indicators of infant mortality and life expectancy. As for the provision of infrastructure we center our attention on the overall quality of public infrastructure.

Musgravian sub-indicators are defined in a similar fashion. We use Gini coefficients as the output indicator for income distribution; price stability (inflation rates) and variability of GDP growth rates for the stability sub-indicator; and GDP per capita, unemployment, and GDP growth rates for economic performance. In the case of the economic variables we use 10-year averages to focus on structural changes instead of yearly fluctuations. The rest of the variables employed correspond to 2010 or the closest available year.

To obtain composite PSP indicators for each country we initially assign equal weights to each sub-indicator (in section 4 we also present results for PSP indicators employing different weights). PSP scores for each sub-indicator are computed as the average of the corresponding outcome variables, each one of them previously normalized by its sample mean. The total PSP indicator for each country is then obtained by averaging the values of all PSP scores for each sub-indicator. To interpret results, PSP scores for each country are then compared to the sample average PSP score, which by constructions has a value of one. Hence, countries with PSP scores in excess of one are seen as good performers, as opposed to countries with PSP values below the mean.

3.2. Public sector efficiency

Performance indicators as defined by the PSP scores do not relate the achievement of public policies to their cost in terms of public spending. To that effect, we initially employ the concept of Public Sector Efficiency to weigh public sector performance for each government activity by the amount of relevant public expenditure (EXP_{ij}) that is used to achieve such

.

performance. This is, for each country $i = 1, \dots, m$ with $j = 1, \dots, n$ areas of government activity and weight w_j applied to the j[th] activity the PSE is defined by:

$$PSE_i = \sum_{j=1}^{n} w_j \frac{PSP_{ij}}{EXP_{ij}}; \sum_{j=1}^{n} w_j = 1. \qquad (2)$$

Hence, government performance in the area of public administration is weighted by spending on government consumption. The achievements in education are related to public spending on the education sector. The same treatment applies to health. The provision of public infrastructure is weighted by public spending on investment. As for the Musgravian tasks of the government, performance on income distribution is related to spending on transfers and subsidies, while outcomes on the functions of the state in terms of stability and economic performance are weighted by total spending. To compute PSE scores for each government activity, public spending categories were previously normalized across countries by their sample means. To obtain total PSE scores for each country, PSP scores per government activity are divided by the relevant spending category as described above. To interpret results, countries with total PSE scores in excess of the sample average are considered as efficient.

The overall assumption behind the assessment of public sector performance and efficiency employing PSP and PSE indicators is that the observed outcome indicators are solely the result of public spending policies. It simply attributes achievements in public administration, education, health, public infrastructure as well as economic performance, stability and income distribution to public policies without acknowledging the effect of expenses incurred by private agents (for instance, households' income devoted to private education and health services) on outcome indicators or any other external factors.

3.3. DEA

Furthermore, we also compute DEA efficiency scores, using notably our PSP composite indicator as an output measure. The DEA methodology, due to Farrell's (1957) and Charnes, Cooper and Rhodes (1978), assumes the existence of a convex production frontier. The production frontier in the DEA approach is constructed using linear programming methods. The

.

term "envelopment" stems from the fact that the production frontier envelops the set of observations.[2]

The general relationship that we consider is given by the following function for each country *i*:

$$Y_i = f(X_i),\ i=1,\ldots,n. \tag{3}$$

where we have Y_i – PSP, our output measure; X_i – the relevant input in country *i* (government spending as a ratio of GDP). If $Y_i < f(X_i)$, then country *i* exhibits inefficiency. For the observed input levels, the actual output is smaller than the best attainable one and inefficiency can be measured by computing the distance to the theoretical efficiency frontier.

For an output-oriented specification, suppose there are *k* inputs and *m* outputs for *n* Decision Management Units (DMUs). For the i-th DMU, y_i is the column vector of the outputs and x_i is the column vector of the inputs. We can define *X* as the $(k\times n)$ input matrix and *Y* as the $(m\times n)$ output matrix. For a given i-th DMU the DEA model is:[3]

$$\begin{aligned} &Max_{\ \delta,\lambda}\ \delta \\ &\text{s. to} \quad -\delta y_i + Y\lambda \geq 0 \\ &\qquad\quad x_i - X\lambda \geq 0 \\ &\qquad\quad n1'\lambda = 1 \\ &\qquad\quad \lambda \geq 0 \end{aligned} \tag{4}$$

In (4), δ is a scalar (that satisfies $1/\delta \leq 1$), more specifically it is the efficiency score that measures technical efficiency. It measures the distance between a country and the efficiency frontier, defined as a linear combination of the best practice observations. With $1/\delta<1$, the country is inside the frontier (i.e. it is inefficient), while $\delta=1$ implies that the country is on the frontier (i.e. it is efficient).

The vector of constants λ $(n\times 1)$ measures the weights used to compute the location of an inefficient DMU if it were to become efficient, and *n1* is an n-dimensional vector of ones. The

[2] See Coelli et al. (1998) and Thanassoulis (2001).

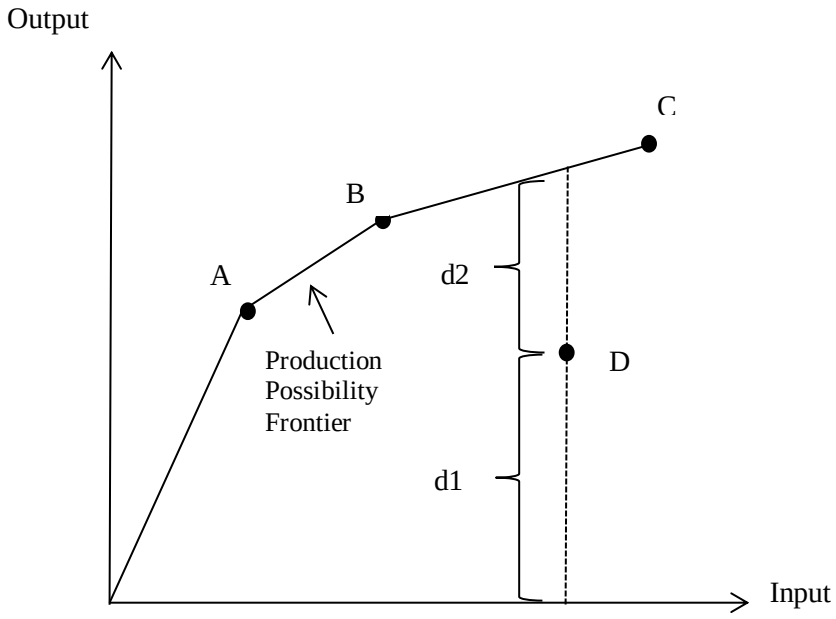
[3] We simply present here the equivalent envelopment form, derived by Charnes et al. (1978), using the duality property of the multiplier form of the original programming model.

.

restriction $n1'\lambda = 1$ imposes convexity of the frontier, accounting for variable returns to scale. Problem (4) has to be solved for each of the *n* DMUs in order to obtain the *n* efficiency scores.

We illustrate in Figure 2 a DEA production possibility frontier in the one input-one output case. For instance, countries A, B and C are efficient with output scores equal to 1. On the other hand, country D is not efficient, since its score [*d2/(d1+d2)*] is below unity.

Figure 2 – DEA Production Possibility Frontier, One Input, One Output



The purpose of an input-oriented study is to evaluate by how much input quantity can be proportionally reduced without changing the output quantities. Alternatively, and by computing output-oriented measures, one could also try to assess 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 different values under variable returns to scale. Nevertheless, both output and input-oriented models will identify the same set of efficient/inefficient countries.

.

4. Empirical analysis

4.1. Data and stylized facts

The data set compiled for this study includes twenty Latin American and three Caribbean countries.[4] We use averages for the period 2001-2010, and some descriptive statistics are provided in Tables A1 and A2 in the Appendix, for the variables used in the construction of the Public Sector Performance index, in the next section.

The composition and size of the sample was determined by availability of data needed to compute the PSP and PSE indicators. Table 1 shows the 2001-2010 average (or within this period according to data availability) for different expenditure categories as shares of GDP for the general government level when available and for the central government otherwise. Total expenditure ranges from 14 to 35 percent of GDP, in line with levels typically spent by developing countries (Herrera and Pang, 2005). Roughly nine out of the twenty-three countries spend under 25 percent of GDP (Guatemala, Dominican Republic, Peru, El Salvador, Paraguay, Chile, Mexico, Costa Rica, and Panama), six between 26 and 30 percent of GDP (Ecuador, Honduras, Colombia, Nicaragua, Trinidad and Tobago, and Suriname), and eight over 30 percent of GDP (Belize, Guyana, Uruguay, Bolivia, Jamaica, Argentina, Venezuela, and Brazil). We will refer to countries in the first group as small governments, countries in the second group as medium-size governments, and countries in the third group as large governments.

Interestingly, on average, small governments have total expenditure ratios of 20 percent of GDP, medium governments of 28 percent of GDP, while large governments spend 33 percent of GDP (sixty percent more than small governments and seventeen percent more than medium-size governments).

[4] Argentina, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Guyana, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Suriname, Trinidad and Tobago, Uruguay, Venezuela RB.

.

Table 1 – Public Expenditure in Sample Countries (% of GDP), 2001-2010

	Total Spending	Government Consumption	Transfers and Subsidies	Interest Payments	Public Investment	Health	Education
Argentina	33.68	12.97	11.39	6.37	2.94	4.91	4.63
Belize	30.32	14.95	3.43	5.03	7.47	2.49	5.62
Bolivia	32.58	11.85	7.58	2.4	7.53	3.48	6.21
Brazil	34.54	20.18	6.86	3.46	1.88	3.44	4.67
Chile	21.84	7.62	10.78	0.78	2.34	3.18	3.81
Colombia	27.6	9.81	8.23	3.68	5.87	5.31	4.17
Costa Rica	24.66	12.54	6.56	3.86	1.54	5.79	5.06
Dominican Republic	17.03	5.97	4.82	1.47	3.02	1.97	2.01
Ecuador	27.37	11.29	7	2.23	7.61	2.15	0.98
El Salvador	19.23	9.98	4.61	2.11	2.53	3.68	3
Guatemala	14.2	5.07	3.14	1.42	1.52	2.3	3.07
Guyana	30.77	12.33	5.23	2.91	10.2	5.89	5.95
Honduras	27.4	16.05	3.04	1.26	4.41	3.62	
Jamaica	32.84	14.71		13.62	2.57	2.46	5.26
Mexico	23.5	11.1	4.68	2.98	2.54	2.66	5.04
Nicaragua	27.62	11.18	8.69	1.88	4.57	4.55	3.12
Panama	24.91	12.98	4.64	3.8	4.08	5.18	4.16
Paraguay	18.04	9.93	3.96	0.88	2.92	2.7	4.52
Peru	19.11	9.89	4.97	1.79	1.93	2.64	2.76
Suriname	28.58	17.61	5.52	1.35	3.96	3.59	
Trinidad and Tobago	27.75	9.01	12.23	2.83	3.9	2.48	4.2
Uruguay	32.34	12.01	12.43	3.88	4.02	4.81	2.55
Venezuela	33.88	12.41	7.69	3.05	10.73	2.38	3.68
Average	26.51	11.8	6.7	3.18	4.35	3.55	4.02
Maximum	34.54	20.18	12.43	13.62	10.73	5.89	6.21
Minimum	14.2	5.07	3.04	0.78	1.52	1.97	0.98
Total Spending, % of GDP, Averages							
<=25%	20.28	9.45	5.35	2.12	2.49	3.34	3.71
>=26% and <=30%	27.72	12.49	7.45	2.21	5.05	3.62	3.12
>30%	32.62	13.92	7.8	5.09	6.4	3.73	4.82

Source: IMF World Economic Outlook (WEO), WB World Development Indicators (WDI), and CEPAL.

Looking at spending categories we observe that government consumption is increasing in size with countries in the third group spending forty-seven percent more on average than countries with small governments. A similar pattern is revealed for transfers and subsidies since

.

large governments spend on average forty-five percent more than the smallest governments, but only five percent more than medium governments. On the other hand, average interest payments are virtually identical between small and medium size governments, while countries with large governments spend 1.4 times more than their counterparts. Public investment is also increasing in the size of the government. On average, large governments spend twenty-six percent more on investment than medium governments and 1.5 times more than small governments.

Differences in health and education spending are much less stressed by the size of governments, as opposed to current expenditures. We found striking similar levels of public spending in health between the three sizes of governments. On average large and medium governments spend 3.6 percent of GDP, while small governments spend 3.3 percent of GDP. In education, large governments spend on average 4.8 percent of GDP, followed by small governments with 3.7 percent of GDP and medium-sized governments with 3.1 percent of GDP.

4.2. Computing the PSP index

Table 2 shows the computed PSP indicators for 2010 for all sample countries. The best performers, according to the overall PSP index, are Chile, Trinidad and Tobago, Panama and Costa Rica. These are the countries whose governments obtain the best results in terms of outcome indicators without taking into consideration the costs incurred to achieve them. On the other hand, countries at the bottom end of the list include Paraguay, Venezuela, and Nicaragua.

Public sector performance for each sub-indicator is also listed in Table 2. Regarding public administration the governments of Chile, Costa Rica, and Uruguay obtain the best scores. In education, Costa Rica, Trinidad and Tobago, and Guyana take the first places. In health, Costa Rica and Chile top the list, while in the provision of public infrastructure Chile, Guatemala, El Salvador and Panama perform the best. For the administrative functions as a whole Chile, Costa Rica, and Uruguay obtain the highest scores. As for the Musgravian functions of the government, Trinidad and Tobago, Nicaragua, and Belize obtain the best results on income distribution; Peru, Belize, and Panama on stability; and Trinidad and Tobago, Guatemala, and Mexico on economic performance. For the overall PSP Musgravian indicator Peru, Panama, Belize and Trinidad and Tobago rank the best.

.

Table 2 – Public Sector Performance (PSP) Indicators, 2010
(Using Quality of Math and Science)

Country	Opportunity Indicators					Musgravian Indicators				Total Public Sector Perforrmance	
	Administration	Education	Health	Infrastructure	**PSP Opportunity**	Distribution	Stability	Economic performance	**PSP Musgravian**	**Equal weights 1/**	**Different weights 2/**
Argentina	0.98	1.15	1.02	0.91	1.01	1.09	0.49	1.08	0.89	0.96	0.92
Belize	0.91	1.03	1.02	0.91	0.97	1.13	1.68	0.83	1.21	1.07	1.15
Bolivia	0.84	1.01	0.94	0.88	0.92	0.86	1.58	0.98	1.14	1.01	1.08
Brazil	0.95	0.90	1.00	0.93	0.95	0.89	0.92	0.94	0.92	0.93	0.92
Chile	1.71	1.08	1.04	1.43	1.32	0.94	1.48	1.16	1.19	1.26	1.22
Colombia	0.98	1.17	1.00	0.93	1.02	0.86	1.28	0.87	1.01	1.02	1.01
Costa Rica	1.37	1.47	1.04	0.93	1.20	0.96	0.77	1.17	0.97	1.10	1.02
Dominican Republic	0.96	0.78	1.00	0.91	0.91	1.03	0.74	0.91	0.90	0.91	0.90
Ecuador	0.85	0.99	1.01	0.96	0.95	0.99	1.06	0.93	0.99	0.97	0.98
El Salvador	0.96	0.86	0.99	1.19	1.00	1.01	1.16	0.78	0.98	1.00	0.99
Guatemala	0.91	0.75	0.98	1.22	0.96	0.86	1.16	1.49	1.17	1.05	1.12
Guyana	1.05	1.23	0.97	0.99	1.06	1.08	0.79	0.56	0.81	0.95	0.88
Honduras	0.92	0.80	0.99	0.96	0.92	0.84	0.93	1.06	0.94	0.93	0.94
Jamaica	1.04	1.11	0.99	1.09	1.06	1.07	0.37	0.58	0.67	0.89	0.77
Mexico	1.03	1.00	1.02	1.09	1.04	1.01	0.79	1.31	1.04	1.04	1.04
Nicaragua	0.80	0.71	1.00	0.80	0.83	1.16	0.85	0.65	0.89	0.85	0.87
Panama	0.85	0.91	1.02	1.19	0.99	0.94	1.59	1.23	1.25	1.10	1.19
Paraguay	0.82	0.81	0.99	0.65	0.82	0.93	0.65	0.88	0.82	0.82	0.82
Peru	0.82	0.98	1.00	0.91	0.93	1.01	1.83	1.07	1.30	1.09	1.21
Suriname	1.05	0.98	0.97	1.09	1.02		1.30	0.92	1.11	1.05	1.05
Trinidad and Tobago	1.15	1.28	0.97	1.14	1.13	1.17	0.76	1.70	1.21	1.17	1.19
Uruguay	1.34	1.07	1.02	1.12	1.14	1.07	0.55	0.95	0.86	1.02	0.93
Venezuela, RB	0.73	1.02	1.01	0.75	0.88	1.08	0.26	0.95	0.76	0.83	0.79
Average	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Maximum	1.71	1.47	1.04	1.43	1.32	1.17	1.83	1.70	1.30	1.26	1.22
Minimum	0.73	0.71	0.94	0.65	0.82	0.84	0.26	0.56	0.67	0.82	0.77
Total spending, % of GDP, averages											
< 25% of GDP	1.05	0.96	1.01	1.06	1.02	0.97	1.13	1.11	1.07	1.04	1.06
>= 26% and <= 30%	0.96	0.99	0.99	0.98	0.98	1.01	1.03	1.02	1.03	1.00	1.01
> 30%	0.98	1.06	1.00	0.95	1.00	1.03	0.83	0.86	0.91	0.96	0.93

Source: Authors' calculations.
Notes: 1/ Each sub-indicator contributes 1/7 to total indicator; 2/ Opportunity indicators contribute 1/16 each (1/4 in total); Musgravian indicators contribute 1/4 each.

.

Moreover, we can also see that PSP is inversely correlated with the size of the government, and the same applies to the sub-indicator so-called Musgravian PSP. Recall that we are labeling countries in terms of the size of the government, as small, medium-size, or large governments, depending respectively on the ratio of government spending-to-GDP being under 25 percent, between 26 and 30 percent, or over 30 percent.

In addition, we also computed the PSP indicators replacing the variable "Quality of Math and Science" by the variable "Literacy Rate", since such indicator is more relevant for this sample country, than, for instance, for OECD countries. Still, such results, as reported in Table 3 show a rather similar picture.

We also computed PSP scores for each model assigning different weights to different sub-indicators. In particular, we assigned the least possible equal weight to administrative sub-indicators whose output indicators are mostly derived from surveys (Eugène, 2008) and placing a higher weight on economic variables. Therefore, we assigned ¾ of the weight to Musgravian sub-indicators and ¼ to opportunity sub-indicators (1/16 each). Results are very similar to the ones obtained applying equal weights. Most countries that obtained PSP scores above the average score of one the first time are also seen as good performers in the second exercise with the exception of Uruguay and El Salvador whose scores were close to the cut-off value of one. Otherwise, the list of countries with PSP scores below one stayed the same as can be observed in tables 2 and 3.

Finally, in an effort to measure public sector performance across time we complement our analysis by computing PSP indicators for 2000. A word of caution is in order when making the comparative analysis. Changes in public sector performance experienced by countries over time are measured relative to that of other countries. Hence, a given country could have improved its PSP score over time either because of the improvement of its output indicators or because other countries in the sample obtained weaker results. Another limitation of the analysis is that when comparing PSP scores over time there is no differentiation of initial conditions among countries. Hence, more advanced countries (in terms of achievement of output indicators) may obtain marginal improvements in some of the output indicators simply because there is little room for them to do so, while less advanced countries may experience the opposite situation.

.

Table 3 – Public Sector Performance (PSP) Indicators, 2010
(Using the literacy Rate)

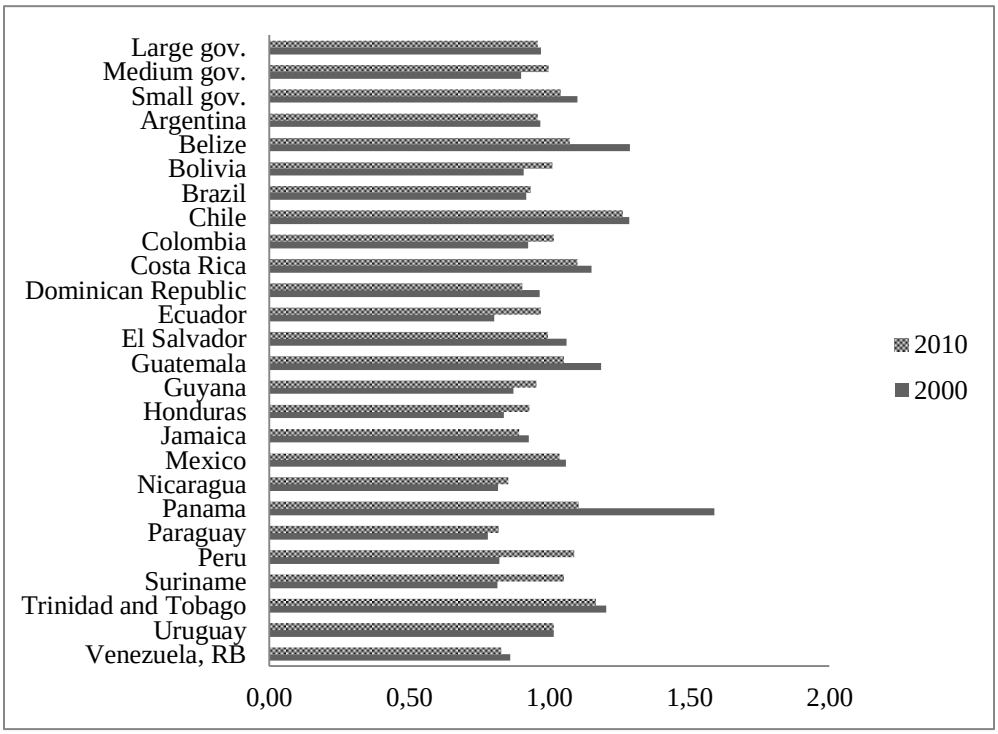
Country	Opportunity Indicators					Musgravian Indicators				Total Public Sector Performance	
	Administration	Education	Health	Infrastructure	**PSP Opportunity**	Distribution	Stability	Economic Performance	**PSP Musgravian**	**Equal weights 1/**	**Different weights 2/**
Argentina	0.98	1.15	1.02	0.91	1.01	1.09	0.49	1.08	0.89	0.96	0.92
Belize	0.91	1.00	1.02	0.91	0.96	1.13	1.68	0.83	1.21	1.07	1.15
Bolivia	0.84	1.01	0.94	0.88	0.92	0.86	1.58	0.98	1.14	1.01	1.08
Brazil	0.95	0.99	1.00	0.93	0.97	0.89	0.92	0.94	0.92	0.95	0.93
Chile	1.71	1.16	1.04	1.43	1.34	0.94	1.48	1.16	1.19	1.27	1.23
Colombia	0.98	1.07	1.00	0.93	1.00	0.86	1.28	0.87	1.01	1.00	1.00
Costa Rica	1.37	1.05	1.04	0.93	1.10	0.96	0.77	1.17	0.97	1.04	1.00
Dominican Republic	0.96	0.95	1.00	0.91	0.95	1.03	0.74	0.91	0.90	0.93	0.91
Ecuador	0.85	0.90	1.01	0.96	0.93	0.99	1.06	0.93	0.99	0.96	0.98
El Salvador	0.96	0.89	0.99	1.19	1.01	1.01	1.16	0.78	0.98	1.00	0.99
Guatemala	0.91	0.72	0.98	1.22	0.96	0.86	1.16	1.49	1.17	1.05	1.12
Guyana	1.05	1.14	0.97	0.99	1.04	1.08	0.79	0.56	0.81	0.94	0.87
Honduras	0.92	0.92	0.99	0.96	0.95	0.84	0.93	1.06	0.94	0.95	0.94
Jamaica	1.04	1.10	0.99	1.09	1.05	1.07	0.37	0.58	0.67	0.89	0.77
Mexico	1.03	1.05	1.02	1.09	1.05	1.01	0.79	1.31	1.04	1.04	1.04
Nicaragua	0.80	0.77	1.00	0.80	0.84	1.16	0.85	0.65	0.89	0.86	0.88
Panama	0.85	1.03	1.02	1.19	1.02	0.94	1.59	1.23	1.25	1.12	1.20
Paraguay	0.82	0.97	0.99	0.65	0.86	0.93	0.65	0.88	0.82	0.84	0.83
Peru	0.82	1.07	1.00	0.91	0.95	1.01	1.83	1.07	1.30	1.10	1.21
Suriname	1.05	0.89	0.97	1.09	1.00		1.30	0.92	1.11	1.04	1.04
Trinidad and Tobago	1.15	1.05	0.97	1.14	1.08	1.17	0.76	1.70	1.21	1.13	1.18
Uruguay	1.34	1.06	1.02	1.12	1.13	1.07	0.55	0.95	0.86	1.01	0.93
Venezuela, RB	0.73	1.06	1.01	0.75	0.89	1.08	0.26	0.95	0.76	0.83	0.79
Average	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Maximum	1.71	1.16	1.04	1.43	1.34	1.17	1.83	1.70	1.30	1.27	1.23
Minimum	0.73	0.72	0.94	0.65	0.84	0.84	0.26	0.56	0.67	0.83	0.77
Total spending, % of GDP, averages											
< 25% of GDP	1.05	0.99	1.01	1.06	1.03	0.97	1.13	1.11	1.07	1.04	1.06
>= 26% and <= 30%	0.96	0.93	0.99	0.98	0.97	1.01	1.03	1.02	1.03	0.99	1.00
> 30%	0.98	1.06	1.00	0.95	1.00	1.03	0.83	0.86	0.91	0.96	0.93

Source: Authors' calculations.
Notes: 1/ Each sub-indicator contributes 1/7 to total indicator; 2/ Opportunity indicators contribute 1/16 each (1/4 in total); Musgravian indicators contribute 1/4 each.

.

Although the comparison of PSP indicators do not offer a dynamic framework, the contrast of two different time periods could still be useful to identify significant changes in performance among groups of countries. Figure 3 shows PSP indicators in 2000 and 2010.

Figure 3 – PSP Indicators in 2000 and 2010 (Equal Weights Using Quality of Math and Science)



Source: Authors' calculations.

It is worth noting that on average, countries with small governments obtain better PSP scores both in 2000 and 2010 than medium and large governments (notwithstanding the slight decline in public sector performance). Medium-sized governments, on the other hand, seem to have improved their PSP scores from 2000 to 2010, although in 2000 they reported the lowest average scores of the three groups. There was little change in performance in the large-government group with marginally lower average scores in 2010 (0.96) when compared with those in 2000 (0.97).

.

4.3. Computing PSE

To assess the efficiency of the public sector we now relate its performance to the cost incurred by governments to achieve it. PSE scores are computed for each country by weighting each sub-indicator by the relevant spending category as described in section 3. Table 4 shows the PSE measures for all countries.

The overall PSE score places Guatemala, Chile, and Peru in the top of the group, followed by the Dominican Republic, Ecuador, and El Salvador. Comparing rankings from the PSP and PSE scores we observe that some of the countries that top the performance list, like Trinidad and Tobago and Panama, are not among the most efficient by PSE scores. This implies that in such countries government performance is obtained at a high cost. On the other hand, countries like Guatemala and the Dominican Republic rank among the efficient countries in spite of not being consider as top performers under the PSP composite indicator. It is noteworthy that most countries with small governments (total public spending below 25 percent of GDP) are efficient according to PSE scores. A similar result is obtained to the change in the "quality of education" variable for "literacy rate" and the use of different weights on PSP sub-indicators.

Looking at PSE scores by sub-indicators we find that the most efficient countries carrying out administrative duties are Chile, Guatemala, and the Dominican Republic. Ecuador, Uruguay, and the Dominican Republic obtain the best scores in education and the Dominican Republic, Ecuador, and Guatemala in health. In the provision of public infrastructure Guatemala, Chile, and Costa Rica top the list. For the overall administrative functions Guatemala, Chile, and Ecuador obtain the best scores while for the overall PSE Musgravian sub-indicators Guatemala, Peru, and Belize are the best ranked. Regarding income distribution, Belize, Honduras, and Guatemala are the most efficient. In terms of economic stability Peru, Guatemala and Chile obtain the highest PSE scores, and Guatemala, Trinidad and Tobago, and Peru score the best in economic performance.

.

Table 4 – Public Sector Efficiency (PSE) Indicators, 2010
(Using Quality of Math and Science)

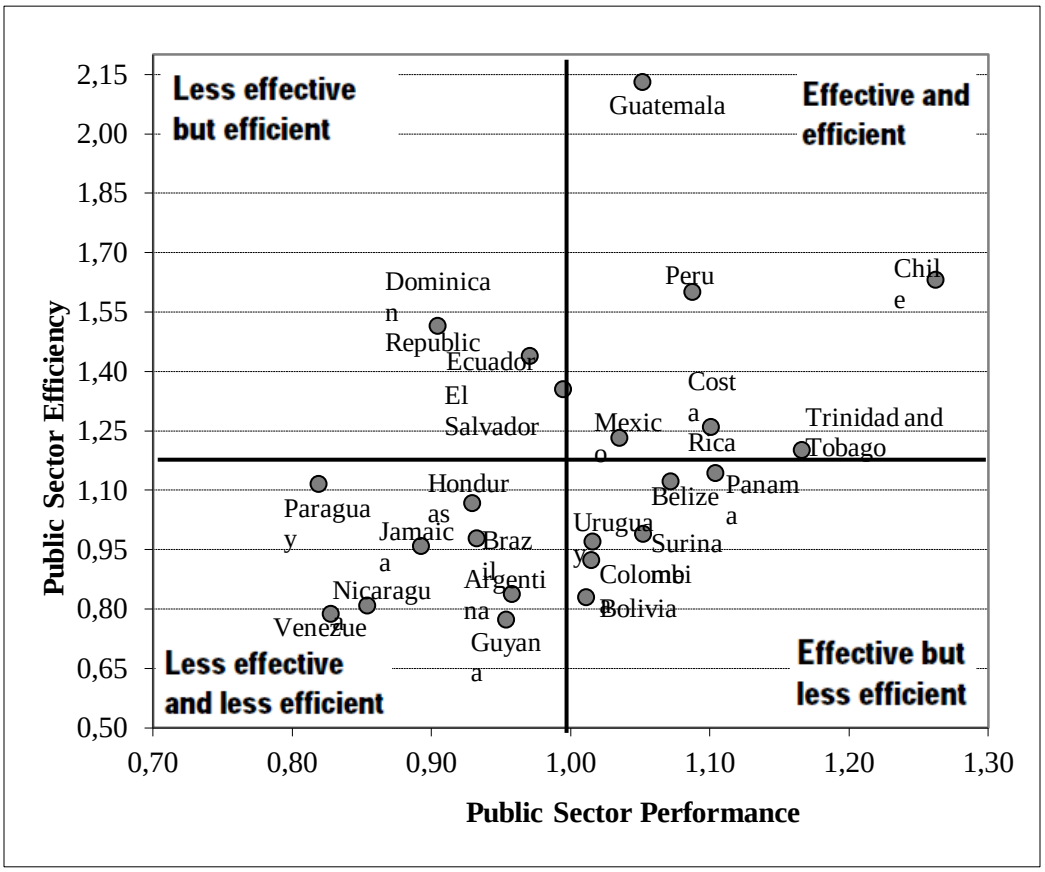
	Opportunity Indicators					Musgravian Indicators				Total Public Sector Efficiency	
Country	Administration	Education	Health	Infrastructure	**PSE Opportunity**	Distribution	Stability	Economic Performance	**PSE Musgravian**	**Equal weights 1/**	**Different weights 2/**
Argentina	0.89	1.00	0.74	1.35	0.99	0.64	0.39	0.85	0.63	0.84	0.72
Belize	0.71	0.74	1.45	0.53	0.86	2.22	1.47	0.72	1.47	1.12	1.32
Bolivia	0.83	0.65	0.96	0.51	0.74	0.76	1.29	0.80	0.95	0.83	0.89
Brazil	0.55	0.78	1.03	2.18	1.13	0.87	0.71	0.72	0.77	0.98	0.86
Chile	2.65	1.14	1.16	2.67	1.91	0.58	1.79	1.41	1.26	1.63	1.42
Colombia	1.18	1.13	0.67	0.70	0.92	0.70	1.23	0.84	0.92	0.92	0.92
Costa Rica	1.29	1.17	0.64	2.65	1.44	0.98	0.82	1.25	1.02	1.26	1.12
Dominican Republic	1.90	1.56	1.79	1.32	1.64	1.44	1.15	1.42	1.34	1.51	1.41
Ecuador	0.89	4.06	1.68	0.55	1.80	0.95	1.03	0.90	0.96	1.44	1.17
El Salvador	1.14	1.16	0.95	2.06	1.33	1.47	1.60	1.08	1.38	1.35	1.37
Guatemala	2.12	0.98	1.51	3.51	2.03	1.84	2.16	2.79	2.26	2.13	2.21
Guyana	1.00	0.83	0.58	0.42	0.71	1.39	0.68	0.49	0.85	0.77	0.82
Honduras	0.68		0.98	0.95	0.87	1.86	0.90	1.03	1.26	1.06	1.06
Jamaica	0.83	0.85	1.44	1.86	1.24		0.30	0.47	0.39	0.96	0.96
Mexico	1.09	0.80	1.37	1.55	1.20	1.44	0.89	1.47	1.27	1.23	1.25
Nicaragua	0.84	0.91	0.78	0.77	0.83	0.90	0.82	0.63	0.78	0.81	0.79
Panama	0.77	0.88	0.70	1.28	0.91	1.36	1.69	1.31	1.45	1.14	1.32
Paraguay	0.98	0.73	1.30	0.97	0.99	1.58	0.95	1.30	1.27	1.11	1.20
Peru	0.97	1.43	1.35	2.06	1.45	1.37	2.53	1.48	1.79	1.60	1.71
Suriname	0.70		0.96	1.20	0.96		1.21	0.85	1.03	0.99	0.99
Trinidad and Tobago	1.50	1.22	1.39	1.28	1.35	0.64	0.73	1.62	1.00	1.20	1.09
Uruguay	1.31	1.69	0.75	1.21	1.24	0.58	0.45	0.78	0.60	0.97	0.76
Venezuela, RB	0.69	1.11	1.50	0.31	0.90	0.94	0.21	0.74	0.63	0.79	0.70
Average	1.11	1.18	1.12	1.39	1.19	1.17	1.09	1.08	1.10	1.16	1.13
Maximum	2.65	4.06	1.79	3.51	2.03	2.22	2.53	2.79	2.26	2.13	2.21
Minimum	0.55	0.65	0.58	0.31	0.71	0.58	0.21	0.47	0.39	0.77	0.70
Total Spending, % of GDP, Averages											
< 25% of GDP	1.44	1.09	1.20	2.01	1.43	1.34	1.51	1.50	1.45	1.44	1.45
>= 26% and <= 30%	0.97	1.83	1.08	0.91	1.12	1.01	0.99	0.98	0.99	1.07	1.00
> 30%	0.85	0.96	1.06	1.05	0.98	1.06	0.69	0.70	0.78	0.91	0.88

Source: Authors' calculations.
Notes: 1/ Each sub-indicator contributes 1/7 to total indicator; 2/ Opportunity indicators contribute 1/16 each (1/4 in total); Musgravian indicators contribute 1/4 each.

.

Figure 4 further illustrates this efficiency and performance assessment by placing the countries into four quadrants taking into account those two dimensions. Therefore, we see that some countries have a good performance (the two right-hand side quadrants), such as Chile, Peru, Bolivia and Colombia, but these can then be split into more efficient (upper quadrant) and less efficient (lower quadrant). On the other hand, the two left-hand side quadrants depict cases of lower performance, and particularly the lower left-hand side quadrant, where we can see a sub-sample of less effective and less efficient countries.

Figure 4 - PSP and PSE in 2010 (Using Quality of Math and Science)



Source: Authors' calculations.

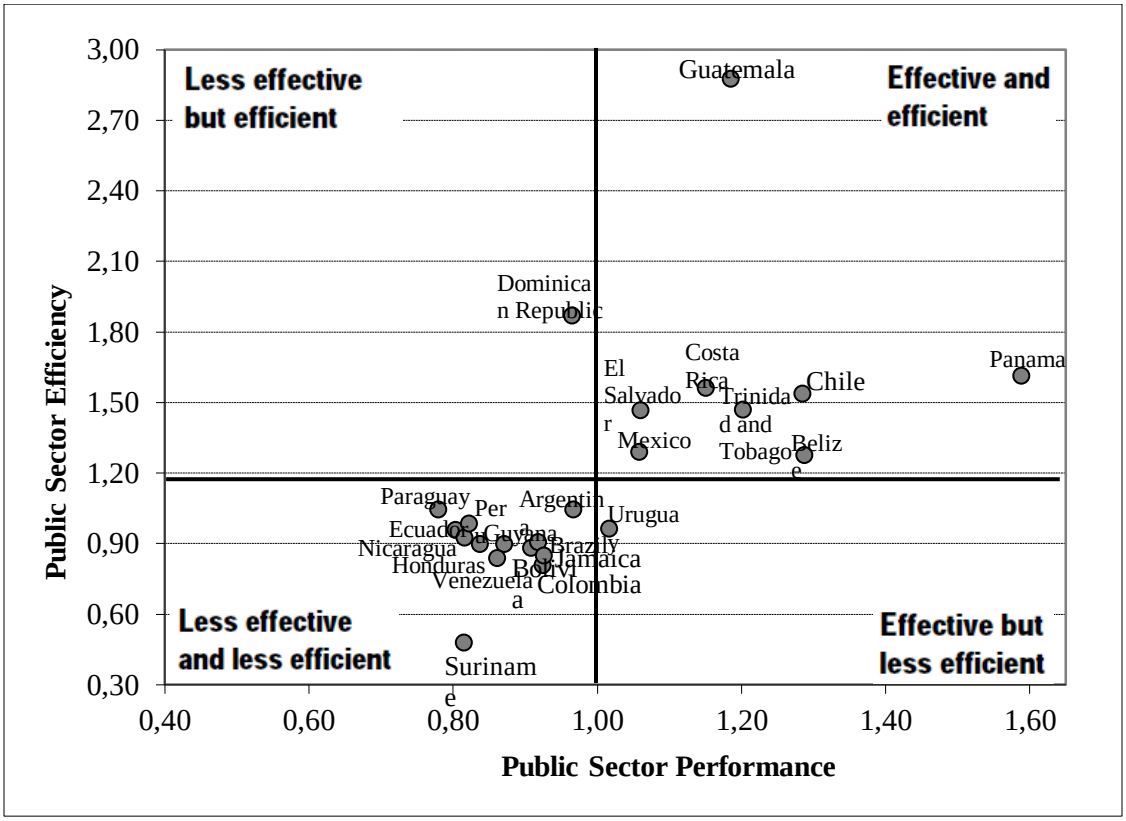
Finally, we also computed the PSE scores for the year 2000 (see illustration in Figure 5). It is worth noting that results were very similar to the ones obtained with 2010 data: countries that were efficient/inefficient in 2010 were also efficient/inefficient in 2000, with the exception of four cases. Ecuador and Peru had PSE scores below the sample average in the year 2000 and

.

above the average in 2010, implying an improvement in their relative efficiency during the decade. On the contrary, Belize and Panama experienced the opposite situation.

Results for country groups in terms of the size of the government are as follows. On average, only small governments obtained efficiency scores above the sample mean in both periods. The medium-sized country group obtained average PSE scores below the sample mean in both years, although with a slight improvement in relative efficiency from period to period. The large-size country group, on the contrary, not only posted lower PSE scores than the sample average in both periods, but saw their efficiency scores worsen from 2000 to 2010.

Figure 5 - PSP and PSE in 2000 (Using Quality of Math and Science)



Source: Authors' calculations.

When placing countries in the efficiency and performance dimensions employing the PSP and PSE scores for the year 2000 we observe that they are mainly clustered into two quadrants, the effective and efficient group and the less effective and less efficient group, with majority of countries laying in the latter group. The higher country dispersion observed in Figure 4 when contrasted to figure 5 illustrates improvement in scores over the decade, particularly in PSP.

.

4.4. DEA results

In order to better clarify the efficiency analysis we also assess public sector efficiency applying the DEA approach using the PSP scores as an output and total spending-to-GDP ratios as input. We find that the efficiency frontier is defined by Guatemala and Chile. Guatemala is placed closed to the origin of the frontier, indicating that the country has low spending levels and low attainment indicators. This particular result does not imply that the country's spending level is either optimal or desirable by any metric. Moreover, the result only points out that the country is technically efficient but offers no implications on the desirability of the outcome levels attained by the country. A similar result is obtained by Herrera and Pang (2005) when assessing the efficiency of the educational sector, finding Guatemala as an efficient country placed on the efficiency frontier. The DEA results are reported in Table 5, and we find that efficiency scores rank countries in a similar fashion than the PSE does, but now we have more information, notably regarding the peers of each country that is not in the production possibility frontier, which is also graphically illustrated in Figure 6. On average, input efficiency score is 60 percent while output efficiency score is 81 percent. This means that countries can achieve the same level of outcome using 40 percent less spending or can increase their performance by 19 percent with the same level of inputs.

.

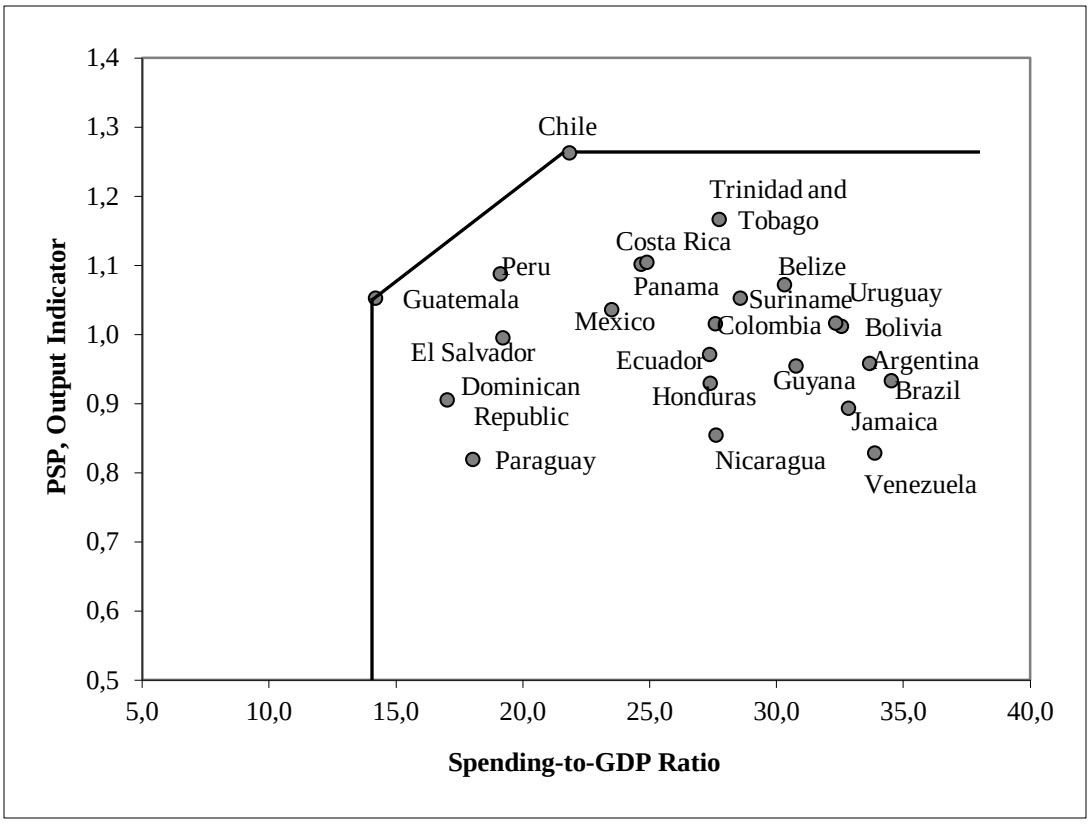
Table 5 – DEA Results, 2010
(1 Input, Government Spending; 1 Output, PSP)
(Using Quality of Math and Science)

	Input oriented		Output oriented		Peers		
	VRSTE	Rank	VRSTE	Rank	Input / Output	CRSTE	Rank
Argentina	0.422	21	0.759	16	GUA/CHI	0.384	20
Belize	0.492	16	0.849	7	GUA,CHI/CHI	0.477	14
Bolivia	0.436	19	0.801	13	GUA/CHI	0.419	17
Brazil	0.411	23	0.739	18	GUA/CHI	0.364	22
Chile	1.000	1	1.000	1	CHI/CHI	0.780	2
Colombia	0.514	13	0.804	12	GUA/CHI	0.496	12
Costa Rica	0.648	8	0.872	6	GUA,CHI/CHI	0.602	7
Dominican Republic	0.833	3	0.801	14	GUA/GUA,CHI	0.717	4
Ecuador	0.519	11	0.769	15	GUA/CHI	0.479	13
El Salvador	0.738	6	0.836	8	GUA/CHI,GUA	0.698	5
Guatemala	1.000	1	1.000	1	GUA/GUA	1.000	1
Guyana	0.461	17	0.755	17	GUA/CHI	0.418	18
Honduras	0.518	12	0.736	19	GUA/CHI	0.458	15
Jamaica	0.432	20	0.707	21	GUA/CHI	0.367	21
Mexico	0.604	10	0.820	10	GUA/CHI	0.595	9
Nicaragua	0.514	14	0.676	22	GUA/CHI	0.417	19
Panama	0.646	9	0.875	5	GUA,CHI/CHI	0.598	8
Paraguay	0.787	5	0.708	20	GUA/CHI,GUA	0.613	6
Peru	0.811	4	0.916	4	GUA,CHI/CHI,GUA	0.768	3
Suriname	0.497	15	0.834	9	GUA/CHI	0.497	11
Trinidad and Tobago	0.661	7	0.924	3	CHI,GUA/CHI	0.567	10
Uruguay	0.439	18	0.805	11	GUA/CHI	0.424	16
Venezuela, RB	0.419	22	0.656	23	GUA/CHI	0.330	23
Average	0.60		0.81			0.54	
Maximum	1.00		1.00			1.00	
Minimum	0.41		0.66			0.33	
Standard Deviation	0.18		0.09			0.17	
Total Spending, % of GDP, Averages							
< 25% of GDP	0.79		0.87			0.71	
>= 26% and <= 30%	0.54		0.79			0.49	
> 30%	0.44		0.76			0.40	

Source: Authors' calculations.
Notes: 1) VRS TE is variable returns to scale technical efficiency. 2) Countries in bold are located on the VRS efficiency frontier. 3) CRSTE is constant returns to scale technical efficiency. CHI-Chile; GUA-Guatemala.

.

Figure 6 – Production Possibility Frontier 2010
(DEA, 1 Input, Government Spending; 1 Output, PSP)
(Using Quality of Math and Science)



Source: Authors' calculations.

For comparative purposes we computed DEA scores, still with one input and one output, for the case where the PSP is computed using the literacy rate instead of the quality of math and science. Results are very similar (Table 6).

.

Table 6 – DEA Results, 2010
(1 Input, Government Spending; 1 Output, PSP)
(Using Literacy Rate)

	Input oriented		Output oriented		Peers		
	VRSTE	Rank	VRSTE	Rank	Input / Output	CRSTE	Rank
Argentina	0.42	21	0.75	16	GUA/CHI	0.39	20
Belize	0.49	16	0.84	6	GUA,CHI/CHI	0.48	13
Bolivia	0.44	19	0.79	13	GUA/CHI	0.42	18
Brazil	0.41	23	0.74	18	GUA/CHI	0.37	21
Chile	1.00	1	1.00	1	CHI/CHI	0.79	2
Colombia	0.51	13	0.79	14	GUA/CHI	0.49	12
Costa Rica	0.58	10	0.82	9	GUA/CHI	0.57	9
Dominican Republic	0.83	4	0.82	8	GUA/GUA,CHI	0.74	4
Ecuador	0.52	11	0.75	15	GUA/CHI	0.47	14
El Salvador	0.74	6	0.83	7	GUA/CHI,GUA	0.70	5
Guatemala	1.00	1	1.00	1	GUA/GUA	1.00	1
Guyana	0.46	17	0.74	19	GUA/CHI	0.41	19
Honduras	0.52	12	0.74	17	GUA/CHI	0.47	15
Jamaica	0.43	20	0.70	21	GUA/CHI	0.37	22
Mexico	0.60	9	0.82	10	GUA/CHI	0.60	8
Nicaragua	0.51	14	0.68	22	GUA/CHI	0.42	17
Panama	0.67	7	0.88	5	GUA,CHI/CHI	0.61	7
Paraguay	0.79	5	0.72	20	GUA/CHI,GUA	0.63	6
Peru	0.84	3	0.92	3	GUA,CHI/CHI,GUA	0.78	3
Suriname	0.50	15	0.82	11	GUA/CHI	0.49	11
Trinidad and Tobago	0.62	8	0.89	4	GUA,CHI/CHI	0.55	10
Uruguay	0.44	18	0.80	12	GUA/CHI	0.42	16
Venezuela, RB	0.42	22	0.65	23	GUA/CHI	0.33	23
Average	0.60		0.80			0.54	
Maximum	1.00		1.00			1.00	
Minimum	0.41		0.65			0.33	
Standard deviation	0.18		0.09			0.17	
Total spending, % of GDP, averages							
< 25% of GDP	0.78		0.87			0.71	
>= 26% and <= 30%	0.53		0.78			0.48	
> 30%	0.44		0.75			0.40	

Source: Authors' calculations.
Notes: 1) VRS TE is variable returns to scale technical efficiency. 2) Countries in bold are located on the VRS efficiency frontier. 3) CRSTE is constant returns to scale technical efficiency. CHI-Chile; GUA-Guatemala.

In addition, we redid the analysis using instead of the overall PSP indicator, two inputs, which are the so-called opportunity PSP and Musgravian PSP sub-indicators. The results in Table 7 show that in this case, and besides Chile and Guatemala, also now Peru shows up in the efficiency frontier. In fact, Peru was rather close the frontier in the one input and one output set of results. Finally, Table 8 summarizes the set of DEA results.

.

Table 7 – DEA Results, 2010
(1 Input, Government Spending; 2 Outputs, PSP-Opportunity, PSP-Musgravian)
(Using Quality of Math and Science)

	Input Oriented		Output Oriented		Peers		
	VRSTE	Rank	VRSTE	Rank	Input / Output	CRSTE	Rank
Argentina	0.453	20	0.769	19	GUA,CHI/CHI	0.443	19
Belize	0.529	14	0.950	6	GUA,PER,CHI/PER,CHI	0.485	17
Bolivia	0.436	21	0.893	9	GUA/PER,CHI	0.424	21
Brazil	0.411	23	0.757	20	GUA/CHI,PER	0.403	22
Chile	1.000	1	1.000	1	CHI/CHI	0.888	2
Colombia	0.560	11	0.828	14	GUA,CHI/CHI,PER	0.546	11
Costa Rica	0.786	6	0.914	7	CHI,GUA/CHI	0.719	6
Dominican Republic	0.833	4	0.833	13	GUA/GUA,CHI	0.789	4
Ecuador	0.519	16	0.808	15	GUA/CHI,PER	0.514	14
El Salvador	0.783	7	0.839	12	GUA,CHI/CHI,GUA	0.769	5
Guatemala	1.000	1	1.000	1	GUA/GUA	1.000	1
Guyana	0.529	15	0.805	16	GUA,CHI/CHI	0.507	15
Honduras	0.518	17	0.769	18	GUA/CHI,PER	0.495	16
Jamaica	0.494	19	0.803	17	GUA,CHI/CHI	0.474	18
Mexico	0.671	10	0.850	11	GUA,CHI/CHI,PER	0.650	8
Nicaragua	0.514	18	0.719	21	GUA/CHI,PER	0.441	20
Panama	0.733	8	0.980	4	PER,GUA,CHI/PER,CHI	0.610	9
Paraguay	0.787	5	0.718	22	GUA/GUA,CHI	0.669	7
Peru	1.000	1	1.000	1	PER/PER	0.826	3
Suriname	0.542	13	0.896	8	GUA,CHI/CHI,PER	0.527	12
Trinidad and Tobago	0.690	9	0.979	5	CHI,GUA,PER/CHI,PER	0.602	10
Uruguay	0.555	12	0.863	10	GUA,CHI/CHI	0.518	13
Venezuela, RB	0.419	22	0.665	23	GUA/CHI	0.381	23
Average	0.64		0.85			0.59	
Maximum	1.00		1.00			1.00	
Minimum	0.41		0.67			0.38	
Standard Deviation	0.19		0.10			0.17	
Total Spending, % of GDP, Averages							
< 25% of GDP	0.84		0.90			0.77	
>= 26% and <= 30%	0.56		0.83			0.52	
> 30%	0.48		0.81			0.45	

Source: Authors' calculations.
Notes: 1) VRS TE is variable returns to scale technical efficiency. 2) Countries in bold are located on the VRS efficiency frontier. 3) CRSTE is constant returns to scale technical efficiency. CHI-Chile; GUA-Guatemala; PER-Peru.

.

Table 8 – Descriptive Statistics of DEA Efficiency Scores and Model Specification, 2010

			Model1	Model2	Model3
Efficiency Scores	Average	Input	0.600	0.597	0.642
		Output	0.810	0.804	0.854
	Maximum		1.000	1.000	1.000
	Minimum	Input	0.411	0.411	0.411
		Output	0.656	0.655	0.665
	Std. Dev.	Input	0.182	0.184	0.190
		Output	0.092	0.090	0.099
Total Countries			23	23	23
Total Efficient Countries			2	2	3
Countries on the Frontier			Chile, Guatemala	Chile, Guatemala	Chile, Guatema, Peru
Inputs			Public Spending	Public Spending	Public Spending
Outputs			PSP (Using Quality of Math and Science)	PSP (Using Literacy Rate)	PSP Opportunity PSP Musgravian
Correlation of Rankings with Model 1		Input		0.994	0.932
		Output		0.968	0.957

Source: Authors' calculations.
Notes: 1) Summary of VRS TE results. 2) Model 1 – 1 input, government spending; 1 output, PSP using quality of math and science. Model 2 – 1 input, government spending; 1 output, PSP (using literacy rate). Model 3 – 1 input, government spending; 2 outputs, PSP-Opportunity, PSP-Musgravian.

As in the previous sections, we extended the DEA methodology to our 2000 data. Results from the one input-one output exercise place Guatemala and Panama in the efficiency frontier with Chile ranking 5th. This would imply a loss in relative efficiency from 2000 to 2010 experienced by Panama, and a relative efficiency gain for Chile over the same period (Table 9). The average input efficiency score in 2000 for the whole sample is 56 percent while the output efficiency score is 67 percent, implying that in the year 2000, countries could achieve the same level of outcome using 44 percent less spending or could increase their performance by 33 percent using the same level of spending. On average, both scores improved in the year 2010 for the group as a whole, suggesting an improvement in efficiency in the region from 2000 to 2010.

.

In the one input-two outputs exercise, Chile joins Guatemala and Panama in the efficiency frontier and so does the Dominican Republic (Table 10).[5]

Table 9 – DEA Results, 2000
(1 Input, Government Spending; 1 Output, PSP)
(Using Quality of Math and Science)

	Input oriented		Output oriented		Peers		
	VRSTE	Rank	VRSTE	rank	Input / output	CRSTE	rank
Argentina	0.457	18	0.609	12	GUA/PAN	0.373	13
Belize	0.536	10	0.810	4	GUA,PAN/PAN	0.454	10
Bolivia	0.451	19	0.572	17	GUA/PAN	0.346	16
Brazil	0.307	23	0.578	15	GUA/PAN	0.238	23
Chile	0.711	5	0.873	3	GUA,PAN/PAN,GUA	0.604	5
Colombia	0.536	11	0.618	11	GUA/PAN,GUA	0.418	11
Costa Rica	0.540	9	0.771	7	GUA/PAN,GUA	0.524	6
Dominican Republic	0.858	3	0.776	6	GUA/GUA,PAN	0.699	2
Ecuador	0.488	14	0.514	23	GUA/PAN,GUA	0.331	18
El Salvador	0.681	6	0.783	5	GUA/GUA,PAN	0.609	4
Guatemala	1.000	1	1.000	1	GUA/GUA	1.000	1
Guyana	0.441	20	0.549	18	GUA/PAN	0.325	20
Honduras	0.507	12	0.545	19	GUA/PAN,GUA	0.358	15
Jamaica	0.471	17	0.583	14	GUA/PAN	0.368	14
Mexico	0.544	8	0.712	9	GUA/PAN,GUA	0.486	7
Nicaragua	0.490	13	0.523	21	GUA/PAN,GUA	0.338	17
Panama	1.000	1	1.000	1	PAN/PAN	0.633	3
Paraguay	0.712	4	0.586	13	GUA/GUA,PAN	0.468	8
Peru	0.596	7	0.575	16	GUA/PAN,GUA	0.413	12
Suriname	0.477	16	0.516	22	GUA/PAN,GUA	0.328	19
Trinidad and Tobago	0.483	15	0.757	8	GUA,PAN/PAN	0.468	9
Uruguay	0.377	22	0.640	10	GUA/PAN	0.323	21
Venezuela, RB	0.390	21	0.542	20	GUA/PAN	0.284	22
Average	0.568		0.671			0.452	
Maximum	1.000		1.000			1.000	
Minimum	0.307		0.514			0.238	
Standard deviation	0.183		0.149			0.170	
Total spending, % of GDP, averages							
< 25% of GDP	0.738		0.786			0.604	
>= 26% and <= 30%	0.497		0.579			0.374	
> 30%	0.429		0.610			0.339	

Source: Authors' calculations.
Notes: 1) VRS TE is variable returns to scale technical efficiency. 2) Countries in bold are located on the VRS efficiency frontier. 3) CRSTE is constant returns to scale technical efficiency. GUA-Guatemala; PAN-Panama.

[5] Similar results are obtained when employing the literacy rate variable in the computation of PSP scores.

.

Table 10 – DEA Results, 2000
(1 Input, Government Spending; 2 Outputs, PSP-Opportunity, PSP-Musgravian, Using Quality of Math and Science)

	Input oriented		Output oriented		Peers		
	VRSTE	Rank	VRSTE	Rank	Input / output	CRSTE	rank
Argentina	0.582	13	0.789	12	DOM,CHI/CHI	0.5639	13
Belize	0.562	14	0.857	8	GUA,CHI,PAN/PAN,CHI	0.504661	15
Bolivia	0.455	21	0.650	20	GUA,DOM/CHI,PAN	0.428594	21
Brazil	0.386	23	0.782	13	DOM,CHI/CHI	0.375681	23
Chile	1.000	1	1.000	1	CHI/CHI	0.871911	3
Colombia	0.619	11	0.735	15	DOM,GUA/CHI	0.616295	10
Costa Rica	0.779	6	0.870	7	CHI,DOM,GUA/CHI,PAN	0.718749	5
Dominican Republic	1.000	1	1.000	1	DOM/DOM	1	1
Ecuador	0.517	17	0.637	21	GUA,DOM/CHI	0.486399	17
El Salvador	0.824	5	0.880	6	DOM,GUA,CHI/CHI,GUA,DOM	0.802732	4
Guatemala	1.000	1	1.000	1	GUA/GUA	1	1
Guyana	0.474	20	0.665	18	GUA,DOM/CHI,PAN	0.452281	19
Honduras	0.508	18	0.617	22	GUA,DOM/CHI,PAN	0.469253	18
Jamaica	0.600	12	0.789	11	DOM,CHI/CHI	0.581427	12
Mexico	0.673	9	0.794	10	DOM,GUA,CHI/CHI,PAN,GUA	0.652509	6
Nicaragua	0.490	19	0.597	23	GUA/CHI,PAN	0.435619	20
Panama	1.000	1	1.000	1	PAN/PAN	0.651537	7
Paraguay	0.712	7	0.689	16	GUA/DOM,CHI,GUA	0.641375	8
Peru	0.639	10	0.682	17	GUA,DOM/CHI,DOM	0.606048	11
Suriname	0.552	15	0.738	14	DOM,GUA/CHI	0.550295	14
Trinidad and Tobago	0.707	8	0.908	5	CHI,DOM,GUA/CHI,PAN	0.639776	9
Uruguay	0.517	16	0.830	9	DOM,CHI/CHI	0.488632	16
Venezuela, RB	0.418	22	0.661	19	GUA,DOM/CHI,PAN	0.398368	22
Average	0.65		0.79			0.61	
Maximum	1.00		1.00			1.00	
Minimum	0.39		0.60			0.38	
Standard deviation	0.20		0.13			0.18	
Total spending, % of GDP, averages							
< 25% of GDP	0.85		0.88			0.77	
>= 26% and <= 30%	0.57		0.71			0.53	
> 30%	0.50		0.75			0.47	

Source: Authors' calculations.
Notes: 1) VRS TE is variable returns to scale technical efficiency. 2) Countries in bold are located on the VRS efficiency frontier. 3) CRSTE is constant returns to scale technical efficiency. CHI-Chile; DOM-Dominican Republic; GUA-Guatemala; PAN-Panama.

4.5. Non-discretionary factors

The DEA approach considers essentially discretionary inputs, the ones for which quantities can be changed rather autonomously by the policy makers in each country (e. g. government spending). However, exogenous constraints or so-called non-discretionary inputs play a role in the possibility of attaining outputs more efficiently. Among such non-discretionary factors that also influence outcomes we may have socio-economic differences, geographical

.

constraints, household wealth, parental education, and more institutional related characteristics such as the level and quality of property rights, the degree of transparency, the rule of law or the ability to control corruption. The literature proposes several ways of tackling this question, usually via an additional assessment, trying to explain efficiency scores.[6] This is our approach here as well, briefly sketched below.

Let z_i be a $(1\times r)$ vector of non-discretionary outputs. In a typical two-stage approach, the following regression is estimated:

$$\hat{\delta}_i = z_i\beta + \varepsilon_i, \qquad (5)$$

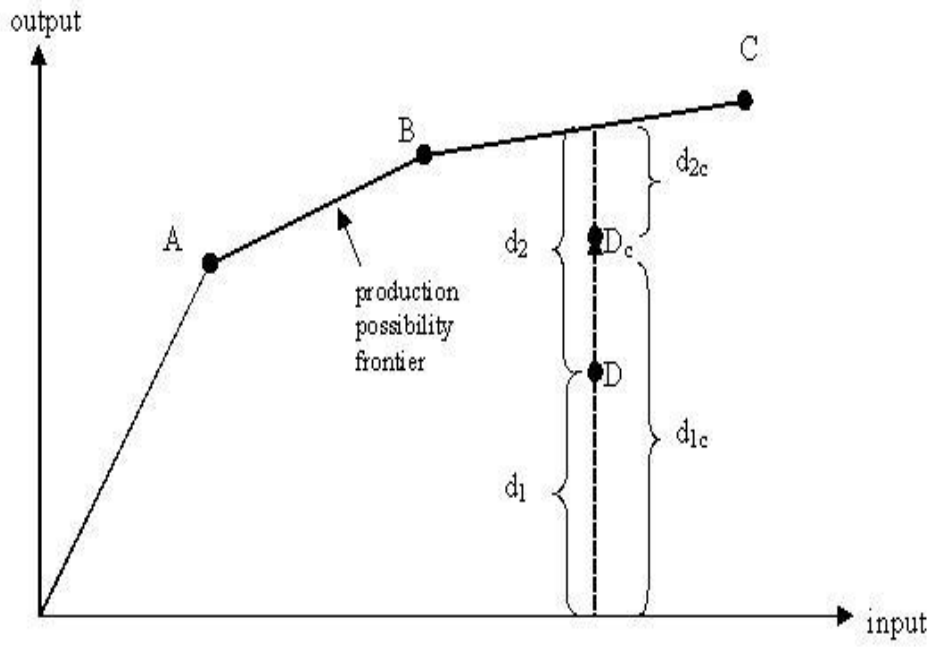
where $\hat{\delta}_i$ is the efficiency score from solving (4), step one. β is a $(r\times 1)$ vector of parameters to be estimated in step two associated with each considered non-discretionary input. Since we know that $\hat{\delta}_i \leq 1$ one can estimate (5) using censored regression techniques (Tobit).

For the purpose of illustration, we can see in Figure 6 that countries A, B and C are efficient, while country D is inefficient. The output score for country D is $d_1/(d_1+d_2)$ and is lower than one. Nevertheless, country D's inefficiency may be partly due to a number of non-discretionary factors forcing country D to produces less than the theoretical maximum, even if discretionary inputs are efficiently used. If the exogenous environment for country D were more favourable, then we could have observed D_c. In other words, country D would have produced more and would be nearer the production possibility. The environment corrected output score would be $d_{1c}/(d_{1c}+d_{2c})$, higher than $d_1/(d_1+d_2)$, and closer to unity.

[6] See Ruggiero (2004) and Simar and Wilson (2007) for an overview.

.

Figure 7 – DEA and non-discretionary outputs



Therefore, we also use a Tobit estimation, to explain the efficiency scores obtained before in the three DEA specifications for 2010 (tables 5 to 7, respectively Model 1, Model 2 and Model 3 and we present in Table 11 those two step results (non-discretionary input data and source are provided in table A4 in the Appendix), using average data for the period 2000-2010 for the non-discretionary factors. It is possible to observe that more transparency and regulatory quality improve the efficiency scores, both from an output and from an input-oriented perspective. On the other hand, property rights and the control of corruption improve the output efficiency scores. In addition, the fit of the estimations is overall always better in explaining the output efficiency scores.

Therefore, better quality indicators, regarding how easy and transparent is for businesses in a given country to obtain information about changes in government policies and regulation affecting their activities, as well as the perceptions of the ability of the government to formulate and implement policies and regulations that permit and promote private activities, seem to constrain the efficiency of the government itself.[7]

[7] We assessed also other non-discretionary institutional factors such as voice and accountability, public trust in politicians, or the rule of law, but they were not as relevant or even statistically significant in explaining the efficiency scores.

.

Table 11 – Censored Normal Tobit Results, 2010 (23 Countries)

	Model 1		Model 2		Model 3	
Dependent Eff. Score	Input	Output	Input	Output	Input	Output
Constant	0.6191	0.8227	0.6155	0.8160	0.6693	0.8708
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
REG	0.1590	0.1126	0.1517	0.1068	0.2024	0.1253
	(0.002)	(0.000)	(0.002)	(0.000)	(0.004)	(0.000)
$\hat{\sigma}_{\varepsilon}$	0.1723	0.0765	0.1756	0.0752	0.1707	0.0823
Constant	0.1682	0.4635	0.1958	0.4865	0.0852	0.4847
	(0.5472)	(0.000)	(0.490)	(0.000)	(0.774)	(0.001)
TRSP	0.1196	0.0956	0.1113	0.0876	0.1550	0.1025
	(0.114)	(0.006)	(0.147)	(0.012)	(0.054)	(0.011)
$\hat{\sigma}_{\varepsilon}$	0.1823	0.0842	0.1849	0.0840	0.1847	0.0909
Constant	0.2796	0.5496	0.2949	0.5597	0.2287	0.5688
	(0.1708)	(0.000)	(0.154)	(0.000)	(0.288)	(0.000)
PROP	0.0829	0.0670	0.0782	0.0628	0.1076	0.0739
	(0.104)	(0.004)	(0.130)	(0.006)	(0.046)	(0.004)
$\hat{\sigma}_{\varepsilon}$	0.1814	0.0826	0.1839	0.0820	0.1827	0.0879
Constant	0.6273	0.8418	0.6217	0.8326	0.6855	0.8909
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
CCORR	0.0704	0.0950	0.0619	0.0846	0.1085	0.1023
	(0.313)	(0.002)	(0.379)	(0.007)	(0.149)	(0.005)
$\hat{\sigma}_{\varepsilon}$	0.1886	0.0814	0.1906	0.0827	0.1923	0.0879

Source: Authors' calculations.

Notes: REG – regulatory quality; *TRSP* – transparency; *PROP* – property rights; *CCORR* – control of corruption. $\hat{\sigma}_{\varepsilon}$ – Estimated standard deviation of ε. p-values in brackets. Model 1 – 1 input, government spending; 1 output, PSP using quality of math and science. Model 2 – 1 input, government spending; 1 output, PSP (using literacy rate). Model 3 – 1 input, government spending; 2 outputs, PSP-Opportunity, PSP-Musgravian.

5. Conclusions

We assess government performance, defined as the outcome of public sector activities, for a sample of twenty-three Latin American and Caribbean Countries for the period 2001-2010, by computing Public Sector Performance (PSP) scores. We also quantify the efficiency of public sectors in achieving such performance by relating PSP scores to public spending by means of Public Sector Efficiency (PSE) and DEA scores. We find that majority of countries with total expenditure-to-GDP ratios below 25 percent perform the best, followed by countries with total spending between 26 and 30 percent and large governments with total spending-to-GDP ratios over 30 percent.

We find similar results applying the DEA methodology where Guatemala and Chile are placed on the efficiency frontier in the one input (total spending)-one output version (PSP scores), joined by Peru in the one input (total spending)-two outputs (PSP-administrative and

.

PSP-Musgravian) model. In both cases, nine out of the top ten most efficient countries (input-oriented approach) are countries with small public sectors. According to the DEA, the sample countries could use on average 40 percent less of the employed resources to attain the same output level, or alternatively increase their output production by 19 percent with the same level of total spending if they were technically efficient.

Employing a Tobit analysis to explain efficiency scores in a second step, we find that notably more transparency and regulatory quality improve the efficiency scores, both from an output and from an input-oriented perspective. On the other hand, more transparency and control of corruption, and better regulatory quality and property rights increase output-oriented efficiency.

In summary, our analysis finds evidence that public sector efficiency is inversely correlated with the size of the government. This result is in line with previous findings for industrialized countries and emerging markets (Afonso et al. (2005, 2010a)).

A final word of caution on the interpretation of results, particularly at the country level, is in order. Public sector performance and efficiency are measured in relative terms only. Hence, country comparisons must be handling carefully and not being taken out of context. According to the employed methodology, improvements in country performance are linked to the achievement of higher output indicators or the worsening of results obtained by its peers. By the same token, efficiency scores are affected by the cost incurred by a country in obtaining such output indicators (public spending), relative to the input-output ratio used by its peers. Finally, even if a country is placed on the efficient DEA frontier, this does not imply that there is no room for improvement either in the achievement of better outcome indicators (directly linked to performance) or the current input/output ratio.

References

Afonso, A. and St. Aubyn, M. 2005. "Non-parametric Approaches to Education and Health Efficiency in OECD Countries". *Journal of Applied Economics*. 8 (2): 227-246.

----. 2006a. "Cross-country Efficiency of Secondary Education Provision: a Semi-parametric Analysis with Non-discretionary Inputs". *Economic Modelling*. 23 (3): 476-491.

.

----. 2006b. “Relative Efficiency of Health Provision: a DEA Approach with Non-Discretionary Inputs.” Working paper No. 33/2006/DE/UECE. Lisbon, Portugal: Department of Economics, School of Economics and Management (ISEG), Technical University of Lisbon.

----. 2011. “Assessing Health Efficiency Across Countries with a Two-Step and Bootstrap Analysis”. *Applied Economics Letters*. 18(15): 1427-1430.

Afonso, A. and Fernandes, S. 2006. “Measuring Local Government Spending Efficiency: Evidence for the Lisbon Region”. *Regional Studies*. 40 (1): 39-53.

----. 2008. “Assessing and Explaining the Relative efficiency of Local Government”. *Journal of Socio-Economics*. 37 (5): 1946-1979.

Afonso, A. and Gaspar, V. 2007. “Dupuit, Pigou and Cost of Inefficiency in Public Services Provision”. *Public Choice*. 132 (3-4): 485-502.

Afonso, A. and Santos, M. 2008. “A DEA Approach to The Relative Efficiency of Portuguese Public Universities”. *Portuguese Journal of Management Studies*. Vol. 13, No. 1: 67-88.

Afonso, A. and Scaglioni, C. 2007. “Efficiency in italian regional public utilities’ provision”. In: M. Marrelli, F. Padovano and I. Rizzo, editors. *Servizi Publici: Nuove tendenze nella regolamentazione, nella produzione e nel finanziamento*. Milano, Italy: FrancoAngeli.

Afonso, A., Schuknecht. L. and Tanzi, V. 2005. “Public Sector Efficiency: An International Comparison”. *Public Choice*. 123 (3): 321-347.

----. 2010a. “Public Sector Efficiency: Evidence for New EU Member States and Emerging Markets”. *Applied Economics*. 42 (17): 2147-2164.

----. 2010b. “Income Distribution Determinants and Public Spending Efficiency”. *Journal of Economic Inequality*. 8 (3): 367-389.

Burgess, J. and Wilson, P. 1998. “Variation in Inefficiency in U.S. Hospitals”. *Canadian Journal of Operational Research and Information Processing*. 36, pp.84-102.

Charnes, A.; Cooper, W. and Rhodes, E. 1978. “Measuring the Efficiency of Decision Making Units”. *European Journal of Operational Research*. 2, 429–444.

Cherchye, L. and Post, T. 2001. “Methodological advances in DEA: A survey and an application for the Dutch electricity sector”. *Erasmus Research Institute of Management Report Series Research in Management*. ERS-2001-53-F&A.

Clements, B. 2002. “How Efficient is Education Spending in Europe?” *European Review of Economics and Finance*. 1 (1): 3–26.

.

Coelli, T.; Rao, P. and Battese, G. 2005. *An Introduction to Efficiency and Productivity Analysis*. *2nd ed.* Kluwer, Boston.

De Borger, B. and Kerstens, K. 1996. "Cost efficiency of Belgian local governments: A comparative analysis of FDH, DEA, and econometric approaches". *Regional Science and Urban Economics* 26, 145-170.

Deprins, D., Simar, L., and Tulkens, H. 1984. "Measuring labor inefficiency in post offices." In: Marchand, M., Pestieau, P. and Tulkens, H, editors. *The Performance of Public Enterprizes: Concepts and Measurements.* Amsterdam, North-Holland.

Eugène, B. 2008. "The efficiency frontier as a method for gauging the performance of public expenditure: a Belgian case study." Working paper No. 138. Brussels, Belgium: National Bank of Belgium.

Evans, D, A. Tandon, Murray, C., and Lauer, J. 2000. "The comparative efficiency of national health systems in producing health: an analysis of 191 countries." *GPE* Discussion Paper Series: No. 29. *World Health Organization.*

Farrell, M. 1957. "The Measurement of Productive Efficiency". *Journal of the Royal Statistical Society*. Series A, 120, Part 3, 253-290.

Geys, B., Heinemann, F., and Kalb, A. 2010. "Voter Involvement, Fiscal Autonomy and Public Sector Efficiency: Evidence from German Municipalities". *European Journal of Political Economy*. 26(2):265–278.

Gupta, S., Verhoeven, M. 2001. "The Efficiency of Government Expenditure – Experiences from Africa". *Journal of Policy Modelling*. 23, 433-467.

Herrera, S., and Pang, G. 2005. "Efficiency of public spending in developing countries: an efficiency frontier approach." Policy Research Working Paper Series 3645. Washington, DC, United States: The World Bank.

Joumard, I., Hoeller, P., André, C., Nicq, C. 2010. *Health Care Systems: Efficiency and Policy Settings*. Washington, DC, United States: OECD.

Ruggiero, J., 2004. "Performance evaluation when non-discretionary factors correlate with technical efficiency". *European Journal of Operational Research.* 159, 250–257.

Schneider, F., Buehn, A., Montenegrog, C. 2010. "Shadow economies all over the world: new estimates for 162 countries from 1999 to 2007." Policy Research Working Paper Series 5356. Washington, DC, United States: World Bank.

.

Simar, L. and Wilson, P. 2007. "Estimation and Inference in Two-Stage, Semi-Parametric Models of Production Processes". *Journal of Econometrics*. 136 (1): 31-64.

St. Aubyn, M. 2003. "Evaluating Efficiency in the Portuguese Education Sector". *Economia*, 26, 25-51.

St. Aubyn, M. 2008. "Law and Order Efficiency Measurement - A Literature Review." Working paper 19/2008/DE/UECE. Lisbon, Portugal: Technical University of Lisbon, School of Economics and Management, Department of Economics.

St. Aubyn, M., Pina, A., Garcia, F. and Pais, J. 2009. "Study on the efficiency and effectiveness of public spending on tertiary education". Economic Papers 390. European Commission.

Sutherland, D., Price, R., Joumard, I., Nicq, C. 2007. "Performance Indicators for Public Spending Efficiency in Primary and Secondary Education." Working Papers, No. 546. OECD Economics Department, OECD Publishing.

Tanzi, V., and Schuknecht, L. 1997. "Reconsidering the Fiscal Role of Government: The International Perspective". *American Economic Review.* 87 (2): 164–68.

----. 2000. "Public Spending in the 20th Century: A Global Perspective". Cambridge: Cambridge University Press.

Thanassoulis, E. 2001. *Introduction to the Theory and Application of Data Envelopment Analysis*. Norwell, Massachusetts, United States: Kluwer Academic Publishers.

Vanden Eeckhaut, P., Tulkens, H., and Jamar, M.-A. 1993. "Cost-efficiency in Belgian municipalities". In: Fried, H.; Lovell, C. and Schmidt, S. editors. *The Measurement of Productive Efficiency: Techniques and Applications*. New York, United States: Oxford Univ. Press.

Wheelock D. and Wilson, P. 2003. "Robust Non-parametric estimation of efficiency and technical change in U.S. Commercial Banking." Working Paper 2003-037A. St. Louis, MO, United States: Federal Reserve Bank of St. Louis.

.

Appendix

Table A1 – Opportunity Indicators, 2010

Country	Corruption	Red Tape	Judicial Independence	Shadow Economy	School enrolment Secondary net	Quality of Math and Science	Literacy Rate	Infant Mortality	Life Expectancy	Infrastructure Quality
Argentina	2.90	2.50	2.60	27.80	82.19	3.20	97.73	12.30	75.63	3.50
Belize	2.90	2.90	3.10	45.60	64.99	3.30	94.10	14.20	75.84	3.50
Bolivia	2.80	3.20	3.00	70.70	68.10	3.00	90.70	41.70	66.27	3.40
Brazil	3.70	2.00	3.70	43.00		2.70	90.04	17.30	73.10	3.60
Chile	7.20	3.60	5.50	21.10	82.56	2.80	98.65	7.70	78.89	5.50
Colombia	3.50	2.90	3.50	45.10	74.39	3.70	93.24	18.10	73.43	3.60
Costa Rica	5.30	3.10	4.90	28.30		4.40	96.06	8.70	79.19	3.60
Dominican Republic	3.00	2.90	2.70	33.60	62.33	1.90	88.24	22.30	73.20	3.50
Ecuador	2.50	2.90	2.30	38.80	58.67	3.30	84.21	17.60	75.46	3.70
El Salvador	3.60	3.40	2.90	49.50	57.58	2.60	84.10	13.90	71.73	4.60
Guatemala	3.20	3.60	2.60	55.00	41.78	2.60	74.47	24.80	70.83	4.70
Guyana	2.70	3.60	3.30	33.30	80.54	3.80	98.80	25.30	69.55	3.80
Honduras	2.40	3.50	3.60	54.20		2.40	83.59	20.30	72.83	3.70
Jamaica	3.30	2.60	4.40	40.50	83.59	2.90	86.36	20.20	72.85	4.20
Mexico	3.10	2.90	3.20	31.30	71.46	2.80	93.44	14.10	76.68	4.20
Nicaragua	2.50	3.20	1.80	47.20	45.77	2.20	78.00	22.60	73.73	3.10
Panama	3.60	3.40	2.10	68.10	68.73	2.40	93.61	17.20	75.97	4.60
Paraguay	2.20	3.50	1.80	42.50	60.04	2.20	94.56	20.80	72.28	2.50
Peru	3.50	2.60	2.60	66.30	77.64	2.40	89.59	14.90	73.76	3.50
Suriname	3.60	2.80	4.40	44.70	50.31	3.60	94.62	26.90	70.34	4.20
Trinidad and Tobago	3.60	3.40	4.40	37.30	68.23	4.60	98.74	24.00	69.76	4.40
Uruguay	6.90	3.10	5.30	56.00	69.56	3.30	98.27	9.20	76.24	4.30
Venezuela, RB	2.00	2.20	1.60	36.30	71.78	2.90	95.15	15.70	74.13	2.90
Average	3.48	3.03	3.27	44.18	67.01	3.00	91.14	18.69	73.55	3.85
Maximum	7.20	3.60	5.50	70.70	83.59	4.60	98.80	41.70	79.19	5.50
Minimum	2.00	2.00	1.60	21.10	41.78	1.90	74.47	7.70	66.27	2.50
Total Spending, % of GDP, Averages										
<= 25%	3.86	3.22	3.14	43.97	65.27	2.68	90.30	16.04	74.73	4.08
>= 26% and <= 30%	3.02	3.12	3.33	44.55	59.47	3.30	88.73	21.58	72.59	3.78
> 30%	3.41	2.84	3.35	44.17	71.72	3.11	93.02	19.35	73.09	3.71

Source: Authors' calculations.

.

Table A2 - Standard "Musgravian" Indicators, 2010

Country	Gini Coefficient	Coefficient of Variation of Growth	Average Inflation	GDP per Capita	GDP Growth	Unemployment
Argentina	44.49	1.55	10.57	11,353.08	4.56	12.71
Belize	42.00	0.64	2.48	6,103.72	3.94	11.07
Bolivia	56.29	0.34	5.28	3,881.97	3.85	5.17
Brazil	54.69	0.71	6.65	8,784.19	3.60	9.85
Chile	52.06	0.59	3.19	12,880.74	3.76	8.89
Colombia	55.91	0.46	5.45	7,527.67	4.10	12.84
Costa Rica	50.73	0.72	10.17	9,331.38	4.28	6.31
Dominican Republic	47.20	0.69	12.41	6,848.98	5.35	15.93
Ecuador	49.26	0.56	6.56	6,479.20	4.40	9.24
El Salvador	48.33	1.06	3.37	5,730.83	1.91	6.68
Guatemala	55.89	0.48	6.79	4,151.47	3.35	2.42
Guyana	44.54	1.10	5.90	2,722.43	2.42	10.45
Honduras	56.95	0.64	7.51	3,295.64	4.09	4.38
Jamaica	45.51	2.60	11.72	7,127.53	0.76	11.83
Mexico	48.28	2.08	4.49	12,191.34	1.66	3.88
Nicaragua	40.47	0.68	8.43	2,338.78	2.94	8.28
Panama	51.92	0.58	2.86	9,891.56	6.32	9.64
Paraguay	52.42	1.20	8.00	4,035.80	4.10	6.97
Peru	48.14	0.58	2.29	6,803.35	5.72	8.87
Suriname		0.34	10.54	6,159.67	4.77	10.25
Trinidad and Tobago	40.3	0.98	6.92	20,354.88	5.69	7.52
Uruguay	45.32	1.49	8.91	10,145.20	3.46	11.62
Venezuela, RB	44.77	2.52	22.67	10,170.00	3.46	11.70
Average	48.89	0.98	7.53	7,752.58	3.85	8.98
Minimum	40.3	0.34	2.29	2,338.78	0.76	2.42
Maximum	56.95	2.6	22.67	2,0354.88	6.32	15.93
Total Spending, % of GDP, Averages						
<=25%	50.55	0.89	5.95	7985.05	4.05	7.73
>=26% and <=30%	48.58	0.61	7.57	7692.64	4.33	8.75
>30%	46.36	1.29	7.48	6888.99	3.17	10.48

Source: Authors' calculations.

.

Table A3 - Variables and Sources

Indices/Variables	Sources	Series and Explanations
Corruption	Transparency International's Corruption Perceptions Index (CPI)	On a Scale From 10 (Very Clean) To 0 (Highly Corrupt).
Red Tape	World Economic Forum 2011-2012	1 = Extremely Burdensome; 7 = Not Burdensome at All
Judicial Independence	World Economic Forum 2011-2012	1 = Heavily Influenced; 7 = Entirely Independent
Shadow Economy	Friedrich Schneider, Andreas Buehn, Claudio E. Montenegro (2010)	% Official GDP. Reciprocal Value 1/X
School Enrolment Secondary Gross	World Bank World Development Indicators (WDI)	Ratio of Total Enrollment
School Enrolment Secondary Net	World Bank World Development Indicators (WDI)	Ratio of Children of Official School Age Based on the International Standard Classification of Education 1997
Quality Of Math and Science	World Economic Forum 2011-2012	1 = Poor; 7 = Excellent – Among the Best in The World
Literacy Rate	World Bank World Development Indicators (WDI)	% Of People Ages 15 And Above
Infant Mortality Rate	World Bank World Development Indicators (WDI)	Per 1,000 Live Births in a Given Year. We Used the Infant Survival Rate: (1000-IMR)/1000
Life Expectancy	World Bank World Development Indicators (WDI)	Life Expectancy at Birth in Years
Infrastructure Quality	World Economic Forum 2011-2012	1 = Extremely Underdeveloped; 7 = Extensive and Efficient by International Standards)
GINI Index	World Bank World Development Indicators (WDI)	0 =Perfect Equality, 100= Perfect Inequality. We Used the Following Transformation 100-GINI
Coefficient of Variation Growth	IMF World Economic Outlook (WEO Database)	Average 2001-2010: Reciprocal Value1/X
Inflation	IMF World Economic Outlook (WEO Database)	Average 2001-2010: Reciprocal Value 1/X
GDP per Capita	World Bank World Development Indicators (WDI)	Average 2001-2010: PPP (Constant 2005 International $)
GDP Growth	IMF World Economic Outlook (WEO Database)	Average 2001-2010: Gross Domestic Product, Constant Prices (Percent Change)
Unemployment	IMF World Economic Outlook (WEO Database)	Average 2001-2010: Reciprocal Value 1/X
For the Following Countries Literacy Rate and GINI Index and Unemployment Rate were Taken from Different Sources:		
Literacy Rate	http://www.indexmundi.com/g/g.aspx?c=bh&v=39	Belize
	http://www.indexmundi.com/g/g.aspx?c=gy&v=39	Guyana
GINI Index	http://www.belize.gov.bz/public/attachment/131612504571.pdf	Belize
	https://www.cia.gov/library/publications/the-world-factbook/fields/2172.html	Guyana
	http://www.nationmaster.com/graph/eco_inc_equ_un_gin_ind-income-equality-un-gini-index	Trinidad and Tobago
Unemployment Rate	World Bank World Development Indicators (WDI)	Bolivia, Guatemala

.

Table A4 – Non-Discretionary Factors

Country	Property Rights	Transparency	Regulatory Quality	Control of Corruption
Argentina	2.60	2.65	-0.63	-0.45
Belize	3.80	3.60	-0.25	-0.23
Bolivia	3.13	3.25	-0.52	-0.60
Brazil	4.63	3.85	0.13	-0.03
Chile	5.40	4.90	1.46	1.42
Colombia	4.43	4.15	0.11	-0.22
Costa Rica	4.73	4.20	0.49	0.53
Dominican Republic	4.23	3.95	-0.26	-0.62
Ecuador	3.30	3.20	-0.91	-0.85
El Salvador	4.47	3.90	0.13	-0.37
Guatemala	3.70	3.25	-0.21	-0.61
Guyana	3.55	4.10	-0.48	-0.52
Honduras	3.47	3.65	-0.36	-0.83
Jamaica	4.60	3.70	0.26	-0.45
Mexico	4.47	3.95	0.35	-0.26
Nicaragua	3.33	3.20	-0.35	-0.66
Panama	4.73	3.70	0.38	-0.32
Paraguay	2.97	3.05	-0.62	-1.19
Peru	3.83	3.65	0.26	-0.28
Suriname	3.70	3.60	-0.62	-0.02
Trinidad and Tobago	4.40	3.95	0.63	-0.18
Uruguay	4.80	4.20	0.35	1.02
Venezuela, RB	2.37	2.60	-1.13	-1.00

Sources:
1/, 2/ - World Economic Forum 2011-2012.
3/, 4/ - Worldwide Governance Indicators (WGI).
Notes:
Data are 2000-2010 averages.
1/ Property rights: 1= are poorly defined and not protected by law, 7 = are clearly defined and well protected by law.
2/ Transparency: How easy is for businesses in your country to obtain information about changes in government policies and regulation affecting their activities? 1 = impossible; 7 = extremely easy
3/ Regulatory Quality: Reflects perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development. -2.5 (weak) to 2.5 (strong) governance performance.
4/ Control of Corruption: Reflects perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests.