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Provision of public goods in a federalist country: Tiebout competition, fiscal equalization, and incentives for efficiency in Switzerland

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**Provision of Public Goods in a Federalist Country:
Tiebout Competition, Fiscal Equalization, and Incentives
for Efficiency in Switzerland**

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Abstract:

The purpose of this paper is to analyze the efficiency of the 26 Swiss cantons over the period 2000 to 2004 applying Data Envelopment Analysis (DEA). A Total Public Sector Performance (TPSP) indicator for eight local government activities (administration, public safety, education, culture and sport, health, transportation, environment and spatial planning, and public economy) is calculated to measure technical efficiency. Efficiency scores are then related to the fiscal equalization scheme designed to reduce disparities between cantons with the expectation to find a negative relationship. Results show the existing scheme to indeed have a negative influence on the performance of financially advantaged cantons. Surprisingly, however, earmarked transfers from the confederation to the cantons are not found to have a stronger negative influence on cantonal performance, contradicting the rationale for their suppression in a recent reform. Most public services fail to exhibit economies of scale, undermining quests for centralization of public good provision and suggesting the possibility of Tiebout competition.

Keywords: DEA, efficiency measurement, federalism, fiscal equalization, public finance, Switzerland, Tiebout competition

JEL: C14, C67, H11, H72, H83

1 Introduction

During the past decade, growing tax burdens have combined with ecological and equity concerns to increase citizens' interest in the efficient provision of public goods. Economists have been responding to this interest by trying to provide information about government performance that may contribute to an economic use of tax revenues. Examples of efficiency measurement of public services include Darke and Simper (2003), who examined the efficiency of police departments in England and Welsh, Worthington et al. (2001) who estimated the efficiency of waste management in South Wales, Chakraborty et al. (2001), as well as Worthington (2001), who focused on U.S. and English public education. Grossman et al. (1999) conclude that competition between U.S. cities serves to increase their efficiency, in line with Tiebout's (1956) hypothesis (see section 2.1 below). For continental Europe, one has Afonso and Fernandes (2006), Afonso and Scaglioni (2005), De Borger and Kerstens (1996) as well as Vanden Eeckaut et al. (1993), who examined the efficiency of Lisbon, Italian, and Belgian local governments, respectively. Specifically, De Borger and Kerstens (1996) find that the tax rate and income per capita have an insignificant effect on the efficiency of Belgian local governments, while grants from federal state have a negative influence. Alfonso et al. (2006), comparing new EU member states and emerging markets, find that trade openness and transparency in government have a positive but insignificant effect on efficiency, while the public trust in politicians fosters inefficiency.

One particular strand of research has benefited from the fact that Switzerland is a very decentralized country. Studies include Filippini and Farsi (2004), Steinmann et al. (2005), Zweifel and Steinmann (2003), Crivelli et al. (2002), as well as Filippini and Wild (2002). Their focus was on health care and energy. In those industries, it is not necessary to take into account of an institutional characteristic of Switzerland (and some other federalist countries), viz. fiscal equalization between member states. Equalization schemes are an instrument designed to reduce fiscal disparities through redistribution between member states (Thöny, 2005). Little attention has been given to the influence of such programs on the performance of both contributing and receiving member states. Indeed, disparities in the provision of public goods could even increase because member states on the receiving end may lack incentives to provide them efficiently. The efficiency of the contributing states may be undermined, too, giving rise to an equity-efficiency trade-off (Stiglitz, 1988).

The contribution of this paper therefore is twofold. First, it measures the efficiency of all 26 Swiss cantons between 2000 and 2004. A Total Public Sector Performance (TPSP) indicator including 8 out of 12 public services is constructed to calculate cantonal efficiency scores based

on Data Envelopment Analysis (DEA). Second, a Tobit model is estimated to relate the calculated efficiency scores to the fiscal equalization scheme operated by the Swiss federal state. The paper seeks to provide answers to two specific questions.

- (1) Does the existing Swiss equalization program contain incentives for cantons (both contributing and receiving) to provide public goods less efficiently, in fact creating a trade-off between equity and efficiency?
- (2) Does it matter whether the transfer payments of the program are earmarked or not?

To the best knowledge of the authors, this is the first contribution undertaking a macroeconomic efficiency measurement of public good provision in Switzerland that takes the incentive effects of the equalization scheme into account.

This paper is organized as follows. The second section provides some background information about Swiss federalism. The third section contains a review of efficiency measurement methods to argue that DEA is the method of choice in the present context. The data used are present in the fourth section. The fifth section is devoted to the presentation of results of the DEA and from a Tobit model estimating the effect of the equalization scheme on DEA efficiency scores. The final section concludes with an outlook and suggestions for future research.

2 SWISS FEDERALISM

2.1 Cantons as the providers of public goods

The Swiss constitution dates of 1848. It distinguishes three levels of government, viz. federal, 26 cantons¹, and approximately 2,900 communities. According to article 3 of the constitution, the cantons are responsible for all public services that are delegated neither to the federal state nor to their affiliated communities. Therefore, cantons are sovereign governmental entities with their own constitution and separation of power (legislative, executive, and judiciary), resulting in a decentralized provision of public goods.

According to article 44 of the federal constitution, cantons are to support each other in the fulfilment of their tasks. Accordingly, public goods are provided in coalition with the federal state or with other cantons, making measurement of cantonal performance difficult. The solution

¹ The 26 Swiss cantons are Zug (ZG), Zurich (ZH), Lucerne (LU), Uri (UR), Schwyz (SZ), Nidwalden (NW), Obwalden (OW), Appenzell Inner-Rhodes (AI), Appenzell Outer-Rhodes (AR), Schaffhausen (SH), Bern (BE), Basel-Country (BL), Basel-City (BS), Argovia (AG), Valais (VS), Jura (JU), Geneva (GE), Vaud (VD), St. Gall (SG), Thurgovia (TG), Ticino (TI), Grisons (GR), Glarus (GL), Neuchatel (NE), Solothurn (SO) and Fribourg (FR).

adopted here is to exclude those four activities that are predominantly performed by the federal state (No. 3, military defense; No. 4, foreign relations; No. 8, social welfare; and No. 12, finance and tax, cf. bracketed items of Table 1). More detailed information about the activities analyzed and performance indicators is provided in the section on data below.

Table 1: Functional structure of public good provision, 2004

2.1.1.1	Activity	Federal State	Cantons	Communities	Total
In Million CHF					
1.	Administration	1,918	3,299	3,637	8,855
2.	Public safety	728	5,287	1,955	7,970
3.	[Military defense]	4,637	157	185	4,979
4.	[Foreign relations]	2,427	-	-	2,427
5.	Education	5,231	14,399	8,055	27,684
6.	Culture & Sport	447	1,380	2,422	4,249
7.	Health	200	12,203	6,922	19,326
8.	[Social welfare]	13,805	8,026	5,911	27,742
9.	Transportation	8,547	2,873	2,991	14,411
10.	Environment & Spatial planning	728	1,019	3,159	4,907
11.	Public economy	4,546	1,287	512	6,344
12.	[Finance & Tax]	9,411	-984	1,059	9,486
Total		52,624	48,947	36,808	138,379

Source: Swiss Federal Statistical Office, 1 CHF = 0.8 USD (2004 exchange rates)

As argued by Tiebout (1956) in his pioneering study, decentralized provision of public goods should have a favorable effect on performance. Similar to a free market economy, where consumers buy from the producer offering the best performance-price ratio, citizens choose their domicile where they get the best ratio between public service and tax paid. Thus, competition for taxpayers is predicted to have a positive effect on cantonal technical efficiency and innovation.

Nevertheless, federalism might also undermine efficiency by causing externalities and disparities. *Externalities* (spillover effects) exist if citizens from one canton cannot be prevented from using services provided by another canton without paying. Externalities typically arise in health care, education, and culture, although those cantons with specialized hospitals do charge higher fees to patients from elsewhere, those with a university levy higher tuitions, and those with an opera house often make other cantons contribute to their operating expense. Still, it is important to adjust for spillovers in order to obtain valid results. *Disparities* are differences due to topographic, demographic, and socioeconomic conditions that are deemed incompatible with the notion of the country as a nation state (Thöny, 2005). Disparities constitute a handicap that cannot be overcome by the affected canton, causing its cost of production to be higher ceteris paribus. However, the experience of the canton of Zug is noteworthy. At the end of World War II, it was one of the three poorest cantons. In 1949, it introduced tax breaks for holding companies on the grounds that company headquarters do not burden the infrastructure nor the environment. By 1980, the canton had the highest per capita income of Switzerland (Swiss Federal Statistical

Office, financial power 1959-2007).

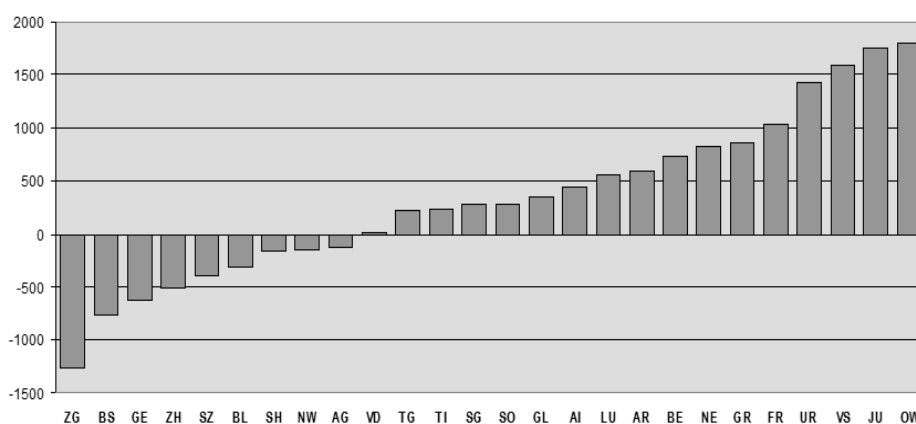
2.2 The Swiss fiscal equalization program

According to article 135 of the federal constitution, cantonal disparities are to be mitigated by a fiscal equalization program. Since 1959, the federal state has pursued fiscal equalization, using an index of financial potential. The formula for this index has four components.

- (1) *Income*: Cantonal income per capita;
- (2) *Tax power*: Taxable income, weighted by the tax burden per capita;
- (3) *Tax burden*: Inverse of the cantonal and communal taxation as a share of *income*;
- (4) *Topographic situation*: Share of a canton's non-mountainous cropland in its total area, weighted by the number of inhabitants per unit of productive land.

A higher total index value results in less financial assistance. Figure 1 shows total payments per capita as of 2004. Not surprisingly, the canton of Zug contributed the maximum of some CHF 1,250 (1CHF = 0.8 USD in 2004) per capita to the program, followed by Basel-City, Geneva, and Zurich. At the other extreme, the 33,000 inhabitants of the canton of Obwalden in central Switzerland received some CHF 1,800 on average. The confederation also distinguishes between earmarked and general payments. Earmarked payments are subsidies for specific projects, while general payments can be used by the canton where it believes to generate the highest benefit for its citizens. In 2004, almost 70 percent of all payments were of the earmarked type.

Figure 1 Payments of the Swiss fiscal equalization program (2004)^{a)}



^{a)}For the acronyms, see footnote no. 1.

Source: Federal Finance Administration (FFA)

However, the existing program has been suspected of inducing the disparities it is designed to alleviate. Especially components No. 2 and 3 of the index formula are seen to create incentives for subsidized cantons to keep their tax burden high, e.g. by using their tax revenue for projects

that contribute little to economic growth but enhance politicians' popularity (Fischer et al., 2003). These concerns have resulted in a reform proposal that passed a popular referendum in 2006. Starting in 2008, the share of earmarked payments will be reduced to a minimum².

Conclusion 1: *The Swiss fiscal equalization program seeks to alleviate cantonal disparities which cause higher production cost for public goods in some cantons. However, inclusion of the tax burden in the payment formula might create incentives for inefficiency among receiving cantons.*

3 EFFICIENT FRONTIER ANALYSIS

3.1 Choice of approach

Koopmans (1951) introduced efficiency measurement to production theory. Given some technology set, an efficient productive unit cannot produce the same output with less input. Equivalently, it cannot increase output with the same amount of input. However, the relevant technology set is almost never known in applied economics, forcing the analyst to use observed rather than efficient input and output quantities. This leaves the choice between parametric (econometric) and non-parametric (mathematical) methods on the one hand and stochastic and deterministic approaches on the other (see Figure 2, where also references to the literature are given). Parametric methods usually amount to the estimation of a specific cost or production function (commonly of the Cobb-Douglas or the Translog type). In the case of a cost function, information about unit prices is needed, which however is almost never available for the public sector. While the non-parametric alternative can do without input prices, it heavily relies on the convexity assumption, amounting to the solution of a linear program. The Free Disposal Hull (FDH) approach constitutes an exception; in return, it does not yield shadow prices.

The distinction between deterministic and stochastic approaches is somewhat fuzzy. While Data Envelopment Analysis (DEA) is deterministic by construction, most authors proceed to analyze calculated inefficiency scores using Stochastic Frontier Analysis (SFA) analysis, an inherently stochastic approach. By way of contrast, all parametric alternatives start from the assumption that observations contain an error term, which SFA splits into a random noise and an inefficiency component.

² For more information about the new equalization program (NFA), see www.nfa.ch.

Figure 2: Overview of efficient frontier specifications

	Non-parametric	Parametric
Deterministic	Data Envelopment Analysis (DEA) - Charnes, Cooper, Rhodes (1978) - Banker, Charnes, Cooper (1984); - Färe, Grosskopf, Lovell (1994) Free Disposal Hull (FDH) - Deprins, Simar, Tulkens (1984)	Corrected/Modified OLS (COLS) - Aigner and Chu (1968) - Richmond (1974)
Stochastic	Stochastic DEA (SDEA) - Land et al. (1993); - Olesen and Petersen (1995)	Stochastic Frontier Analysis (SFA) - Aigner, Lovell, Schmidt (1977) - Meeusen and Van den Broeck (1977)

In public good provision analysis, DEA is the most common alternative. Webster, Kennedy and Johnson (1998) argue that DEA dominates its main competitor SFA, citing the following reasons:

“Most authors cite the inherent flexibility of the DEA model as a major attraction [...]. Another reason for the use of the DEA technique arises when there is lack of realistic price data associated with [...] inputs and outputs. The DEA technique is able to handle multiple outputs of production, reducing the need for price data to form the types of composite measures of output (and even input) required for regression-based techniques.”

DEA is the preferred technique for the present investigation, in particular because of factor prices. Public sector accounts are notorious for neglecting capital user cost, and Switzerland is no exception. However, DEA has its drawbacks, too. First, it fails to account for random noise, rendering results sensitive to measurement error. This may cause a unit that per chance is identified as efficient to define the entire frontier, while other units exhibit a overstated distance from the efficient frontier. Also, when there are many outputs compared to the number of units, DEA tends to recognize most units as efficient. More recent developments, notably Stochastic Data Envelopment Analysis (SDEA) try to overcome these problems. However, they have as of yet hardly resulted on published applications which would permit a comparison with the results of the present investigation.

3.2 Data Envelopment Analysis (DEA)

There are several variants of DEA. This work is based on the input-orientated and constant-returns to scale variant (Charnes et al., 1978). While some public services could conceivably exhibit increasing or decreasing returns to scale, Byrnes and Dollery (2002) have not found significant scale effects for overall local government performance.

The main idea of DEA is to estimate an efficient frontier that is defined by the most productive

unit(s) – one or more Swiss cantons in the present context. Equation (1) below conveys the basic idea. It describes a linear optimization problem for a particular canton C, where Y and X are the output and input matrices, respectively (subscripts dropped for simplicity),

$$\begin{aligned}
& \text{Max } \mu Y_c \\
& \text{s.t. } \quad v X_c = 1 \\
& \quad \quad \mu Y - v X \leq 0 \\
& \quad \quad \mu, v \geq 0.
\end{aligned} \tag{1}$$

Thus, let a canton optimize its outputs Y_c and inputs X_c . However, the distance between inputs and outputs achieved is valued using weights μ and v that relate to the universe of all cantons. Moreover, inputs are normalized to sum up (after weighting) to 1. Finally, the inequality $\mu Y - v X \leq 0$ prevents outputs from increasing without bounds for a given bundle of inputs. Since (1) is a linear program, weights (μ, v) can be interpreted as shadow prices, reflecting the opportunity cost of an extra unit of input or output, respectively. The efficient frontier is defined by those units for which (given weights) $\mu Y - v X = 0$. Their efficiency score is 100 percent, while that of the others is measured by their radial distance from the frontier.

Equation (2) shows the (input-oriented) dual of (1), the so-called envelopment problem,

$$\begin{aligned}
& \text{Min } \theta_c \\
& \text{s.t. } \quad X \lambda \leq \theta_c X_c \\
& \quad \quad Y \lambda \geq Y_c \\
& \quad \quad 0 \leq \lambda \leq 1.
\end{aligned} \tag{2}$$

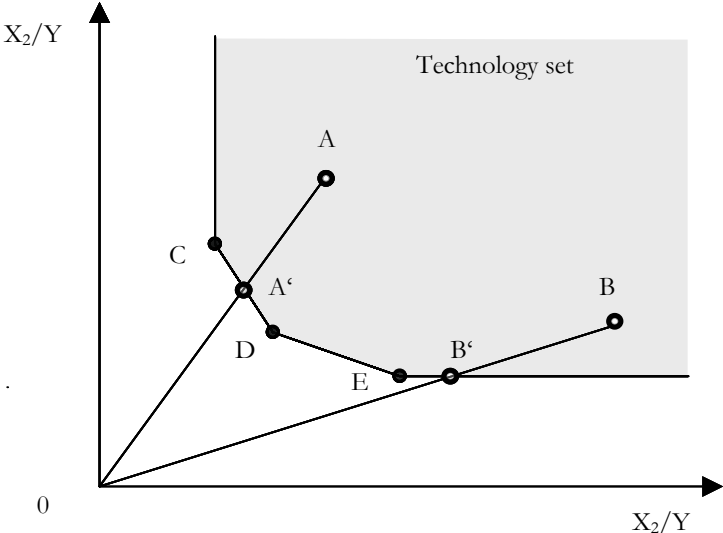
Here $\theta_c \leq 1$ is a scalar representing the cantonal efficiency score. A canton with $\theta_c < 1$ is technically inefficient because its inputs could be scaled back without affecting output.

Figure 3 illustrates the technically efficient frontier for a two-input one-output case with five cantons (A, B, C, D, E). Cantons C, D, and E form the efficient frontier. It amounts to an isoquant defined in terms of inputs X per unit of output Y. The inefficiency of cantons A and B is measured by the radial distance to the frontier. Therefore, assuming constant returns to scale, the technical efficiency (TE) of canton A can be measured by

$$TE_A = \frac{OA'}{OA}, 0 \leq TE_A \leq 1. \tag{3}$$

The reference set A' for unit A in Figure 3 is a combination of the input sets of the two efficient cantons C and D. Unlike A' , set B' is a weak efficient reference set for B because input X_1 can be reduced while moving along the efficient frontier without affecting the level of output. Slacks of this type have to be accounted for in DEA³.

Figure 3: Efficiency Frontier (input-orientated DEA)



Finally, a DEA-efficient unit need not be Pareto-Koopmans efficient because additional units could exist that would shift the frontier outward. Nevertheless, according to Steinmann (2002, ch. 3), the corresponding efficiency bias does not affect inferences concerning efficiency scores as long as the distortion is consistent.

Conclusion 2: *DEA is a widely accepted approach to efficiency measurement. It is suitable for the present analysis because it does not require information about input prices – among them the user cost of capital in particular.*

4 DATA

4.1 The Sample

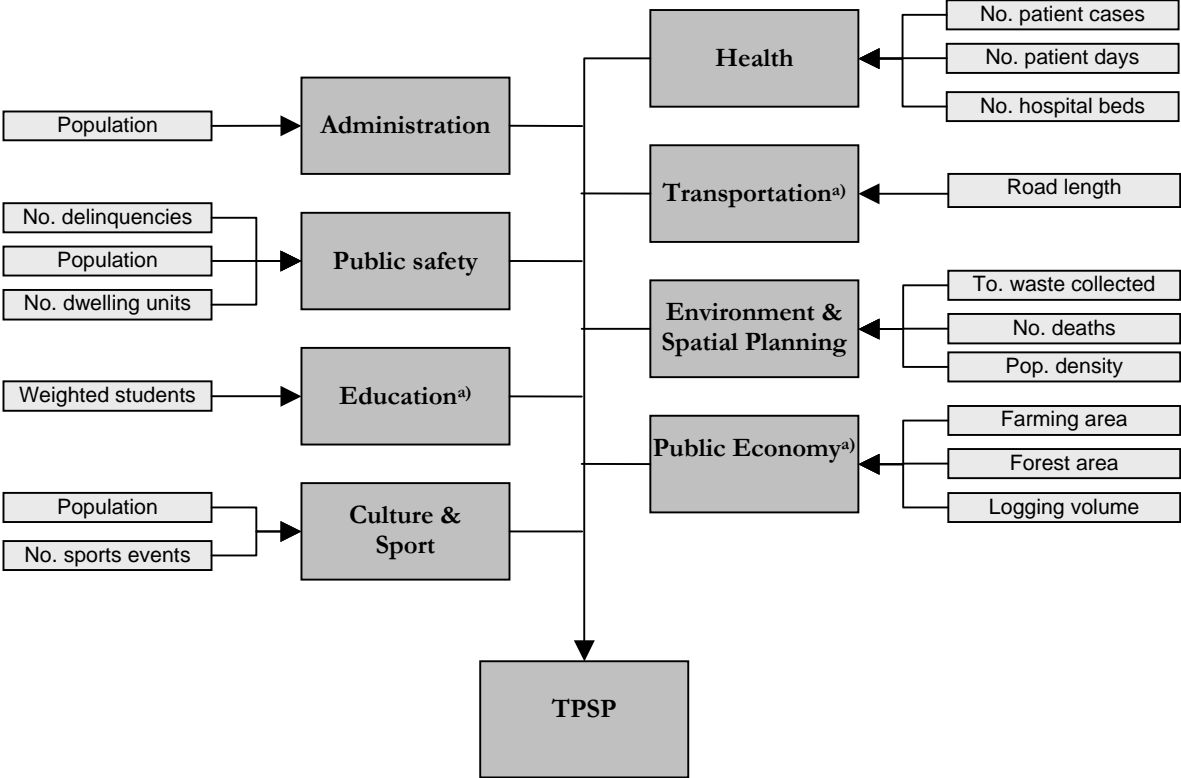
The sample covers all 26 Swiss cantons over the years 2000 to 2004. It includes the eight public services listed in Table 1. In order to exclude spillovers as far as possible, only primary and secondary education (without tertiary and vocational education), private road transportation (without regional public transportation) and farming and forestry are included in the analysis. Unfortunately, adjustments for spillovers (that are known to exist in health care, culture, and sports) were not possible.

³ See Coelli et al. (2005), p. 164. In output-orientated DEA, output slacks may occur as well [see Coelli et al. (2005), p. 180f.].

4.2 Input and output variables

Since outputs of the public sector are difficult to measure, activity-based indicators serve as a substitute. The present paper follows Afonso et al. (2005) in their use of a Total Public Sector Performance (TPSP) indicator to account for aggregate public output. However, data availability dictated a choice of components that differs from theirs. Figure 4 shows the composition of the TPSP output indicator (see appendix for more details).

Figure 4: Total Public Sector Performance (TPSP) Indicator ^{a)}



The relevance of each of the eight components (measured in cantonal real expenditure, CHF of 2000) was estimated by running an OLS regression of Cobb-Douglas form on the one to three output items shown in Figure 4. Explained variance was highest ($R^2 = 0.99$) for education and lowest ($R^2 = 0.81$) for culture and sports; all the other components attained an R^2 value of 0.90 or more. Therefore, estimated regression coefficients can be used as weights in a partial aggregation to the respective eight components of TPSP. The weights used for the aggregation of the eight components making up to the TPSP indicator (measured by real expenditure on each component) are 0.12 for administration, 0.11 for public safety, 0.23 for education, 0.05 for culture and sports, 0.32 for health, 0.06 for transportation, 0.04 for environment and spatial planning, and 0.07 for economy, respectively. As in Afonso et al. (2005), each item of the eight components is normalized by its mean for aggregation to the TPSP indicator.

^{a)} Note: components exclude certain items with mashed spillovers (see text).

The inputs of the DEA are measured by real expenditure (CHF of 2000) of the eight components. This is a widespread practice (see Afonso et al., 2006 and De Borger and Kerstens, 1996).

5 EMPIRICAL RESULTS

5.1 DEA Analysis

Table 2 shows the cantonal DEA efficiency scores for the year 2004. The assumption (to be relaxed below) is that the 26 cantons belong to the same universe, a common presumption in DEA.

Table 2: DEA efficiency scores, 26 Swiss cantons (2004)

Canton ^a	Rank	TPSP	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	S.E.
ZH	23	0.69	0.75	0.61	0.56	0.35	0.69	0.12	0.70	0.12	0.26
BE	6	0.95	0.88	0.74	0.63	0.45	0.95	0.29	0.69	0.48	0.22
LU	19	0.81	0.81	0.61	0.79	0.48	0.61	0.20	0.55	0.43	0.20
UR	5	0.95	0.77	[1.00]	0.69	0.48	0.46	[1.00]	0.60	0.45	0.13
SZ	11	0.89	0.99	0.62	0.86	0.64	0.52	0.31	0.80	0.49	0.22
OW	2	0.97	0.88	0.59	0.85	0.46	0.45	0.69	0.69	0.91	0.18
NW	16	0.86	0.91	0.60	0.79	[1.00]	0.42	0.40	0.81	0.42	0.22
GL	7	0.94	0.84	0.61	0.76	0.47	0.75	0.38	0.86	0.58	0.17
ZG	24	0.65	0.74	0.57	0.60	0.56	0.46	0.14	0.45	0.22	0.20
FR	9	0.90	0.85	0.75	0.83	0.49	0.57	0.36	0.62	0.56	0.17
SO	8	0.92	[1.00]	0.86	0.85	0.60	0.59	0.29	0.84	0.36	0.24
BS	25	0.64	0.58	0.54	0.37	0.36	0.91	0.06	0.50	0.00	0.29
BL	20	0.81	0.93	0.66	0.81	0.55	0.60	0.20	0.58	0.22	0.26
SH	12	0.89	0.83	0.66	0.72	0.67	0.69	0.40	0.61	0.40	0.15
AR	4	0.97	0.83	0.56	0.76	0.61	[1.00]	0.19	0.54	0.56	0.20
AI	14	0.87	0.87	0.51	[1.00]	0.42	0.40	0.18	0.53	0.92	0.26
SG	15	0.87	0.87	0.67	0.79	0.52	0.68	0.24	0.87	0.37	0.23
GR	13	0.88	0.64	0.58	0.51	0.33	0.59	0.58	0.74	[1.00]	0.13
AG	10	0.89	0.95	0.78	0.88	0.51	0.63	0.26	0.86	0.27	0.27
[TG]	1	1.00	0.98	0.70	0.96	0.58	0.72	0.36	0.74	0.51	0.21
TI	18	0.83	0.84	0.64	0.67	0.57	0.70	0.37	0.72	0.17	0.22
VD	22	0.73	0.68	0.69	0.59	0.32	0.62	0.27	0.56	0.26	0.18
VS	3	0.97	0.91	0.79	0.84	0.47	0.70	0.52	[1.00]	0.36	0.21
NE	21	0.74	0.69	0.71	0.66	0.44	0.57	0.22	0.61	0.31	0.18
GE	26	0.52	0.60	0.46	0.49	0.27	0.51	0.05	0.59	0.03	0.23
JU	17	0.85	0.67	0.55	0.62	0.47	0.50	0.44	0.50	0.97	0.17
Mean		0.85	0.82	0.66	0.73	0.5	0.63	0.33	0.68	0.44	
Min		0.52	0.58	0.46	0.37	0.27	0.40	0.05	0.45	0.00	
S.E.		0.12	0.12	0.09	0.14	0.10	0.14	0.15	0.13	0.25	

(1) Administration, (2) Public safety, (3) Education, (4) Culture & Sport, (5) Health, (6) Transportation, (7) Environment & Spatial planning, (8) Public economy

^{a)} For the acronyms, see footnote no. 1.

Starting with TPSP, the canton of Thurgovia (TG) attains 100 percent technical efficiency (score of 1.00). It therefore defines the efficiency frontier. Six more cantons, all of them predominantly rural, come close, viz. Obwalden (OW, 0.97), Valais (VS, 0.97), Appenzell Outer-Rhodes (AR, 0.97), Uri (UR, 0.95), Bern (BE, 0.95), and Glarus (GL, 0.94). At the other extreme, urban Geneva (GE) is identified as the most inefficient canton (0.52). This means that its inputs could have been lowered by 48 percent while still maintaining the same output level.

With regard to size, two small cantons (UR, OW) and one large canton (BE) come close to technical efficiency. Thus, there are no signs of economies of scale, in line with the constant returns to scale assumption but contradicting the notion that mergers of cantons would increase efficiency. For instance, the parliaments of Geneva and Vaud proposed a merger, which however was rejected by both electorates in 2002. Indeed, larger units could even be less efficient because citizens cannot exert as much control over government anymore. Moreover, the likelihood of mismatch between their preferences and the public goods provided may increase. The alternative to mergers could be partnerships designed to provide specific public services that do exhibit economies of scale (Frey, 2005).

The eight components entering the TPSP score are of interest as well. The first thing to note in Table 2 is that the canton of Thurgovia (TG), while being the overall champion, has a low efficiency score in transportation (0.36) and in the management of its economy (0.51). Conversely, last-ranked Geneva (GE) nowhere attains 0.60 while exhibiting extremely low values in the management of its economy (0.03) and transportation (0.05). As evidenced by the standard error across the eight components (see last column of Table 2), low overall rank tends to go along with high variance in component scores. For instance, the canton of Grisons (GR, overall rank 13) has only one component score below one-half (culture and sports, 0.33). Of course, the cantons with high TPSP values cannot exhibit much variation in component scores, whose values are bounded by 1.00.

Finally, some public services may be provided in a more efficient way than others. Indeed, Swiss cantons are rather efficient technically in terms of public administration (No. 1, mean score 0.82), and for the reason stated above, they are rather homogenous in this regard, too. Education (No. 3, mean score 0.73, min. 0.37, S.E. 0.14) follows next. This comes somewhat as a surprise since for years, cantons have been criticized for the inefficiency and parochial orientation of their schools. More specifically, lack of coordination has been cited as a reason for the rather mediocre performance of the Swiss educational system as measured by the PISA study (OECD, 2006). However, these criticisms might be overstated in view of the small difference between the scores of education (No. 3, 0.73) and public administration (No. 1, 0.82), the latter generally being believed to perform well in international comparison. The weakest component clearly is transportation (No. 6, mean score 0.33, min. 0.05, S.E. 0.15). However, this may be due to hidden heterogeneity. Specifically, top scorer Uri (UR) simply does not need to invest much in roads because it is home to a major freeway through the Alps, which falls under the authority of the federal state.

Conclusion 3: *One of the 26 Swiss cantons, the canton of Thurgovia (TG), defines the technically efficient frontier. Low overall efficiency tends to go together with high variability in terms of the eight component scores. However, there are indications suggesting that the assumption of a uniform universe may not hold true with regard to some of these components.*

5.2 Testing the Uniformity Assumption

The typical DEA assumption that all units come from the same universe is crucial. If it fails to hold, calculated efficiency scores could be biased. In their comparison of German and Swiss hospitals, Steinmann et al. (2004) developed the following homogeneity test. They projected the German units on the efficient frontier formed by the Swiss units; then, they projected the Swiss units onto the German frontier. Only those units that lay within the bounds of the other frontier in both projections were retained. In the present context, the categorization of cantons into potentially heterogeneous groups is not self-evident. However, the following three dimensions might reflect heterogeneity,

- (1) Year of observation (2000, 2001, 2002, 2003, 2004);
- (2) Size (TPSP>1);
- (3) Financial power (Index \geq 100).

As to (1), two consecutive years proved to be mutually projectable throughout. With regard to (3), the uniformity assumption did not have to be rejected either. However, categorization (2) proved relevant in that three cantons, viz. Grisons, Fribourg, and Basel-City could not be projected on the respective frontiers formed by all cantons (TPSP>1), resulting in 23 comparable units. This exclusion does not mean that they differ from the remaining cantons in a fundamental way. But they do differ with regard to the outputs and inputs used in the present investigation.

Conclusion 4: *Although the 26 Swiss cantons are very heterogeneous in terms of their DEA efficiency scores, only three of them cannot be projected on an efficiency frontier formed by all cantons (TPSP>1).*

5.3 Determinants of DEA efficiency

In this section, DEA efficiency scores for the comparable 23 Swiss cantons and covering the years 2000 to 2004 are analyzed. Tobit estimation is applied to control for the fact that efficient cantons cannot exceed the maximum efficiency score of 1.00 (the lower limit of 0 is less relevant because it is never binding in the sample). As to the explanatory variables, they should not be correlated with the input quantities included in the DEA because otherwise it would be difficult

to justify why they did not serve as inputs in the first place (Lovell 1993).

In the introductory section, two questions were raised, viz.

- (1) Does the existing Swiss equalization program contain incentives for both contributing and receiving cantons to provide public goods less efficiently, creating a trade-off between equity and efficiency?
- (2) Does it matter whether the transfer payments of the program are earmarked or not?

Accordingly, the two explanatory variables of prime interest are the two following.

- *Index of financial potential* (FIN_POT): This is the indicator on which the Swiss fiscal equalization program is based (see section 2.2). The first hypothesis is examined using the financial power index, which determine the amount of financial adjustment between cantons. An increase in the index means a decrease in federal financial assistance.
- *Subsidies per capita* (SUBS): This variable corresponds to earmarked payments, which are hypothesized to induce even more inefficiency than the fiscal equalization program as a whole (see section 2.2 again).

In addition, the following variables serve to control for other influences on cantonal efficiency scores.

- *Income per capita* (INCOME): This is one component of the FIN_POT index that according to De Borger and Kerstens (1996) has additional information content. They predict that efficiency of local government decreases with increasing income per capita because citizens in high-income jurisdictions, earning a high wage rate, face high opportunity costs when trying to monitor the efficiency by public good provision.
- *Tax burden* (TAX): This component of FIN_POT has additional information content as well. In line with De Borger and Kerstens (1996), citizens' awareness of inefficiency in the public domain is predicted to increase with a higher tax burden. This serves to enforce a higher degree of efficiency, ceteris paribus.
- *Topographic conditions* (TOPOGR): This is one of the three factors entering the new fiscal equalization formula, controlling for exogenously given disparities that affect the cost of public good provision.
- *Industrial structure* (IND_STRUCTURE): In the new formula, effective 2008, this indicator measures differences of community size, the employment rate, and population density, all of which that are expected to cause higher costs.

- *Population structure* (POP_STRUCT): This is the third factor of the formula, controlling for population differences.
- *Spillover effects* (SPILL_B=1): This dummy variable is taken from Fischer (2004), who categorized Swiss cantons into those providing public services without full compensation and those benefiting from them. Thus, SPILL_B=1 for a canton who benefits from spillover effects.
- *Cost of housing* (P_HOUSING): The cost of housing differs substantially between cantons. It is an important component of the cost of living, which in turn determines the cost of providing public services.
- *Direct democracy* (DIR_DEM): The degree of direct democratic control (popular initiatives, mandatory referenda on expensive public projects) was found to be relevant by Pommerehne and Zweifel (1991) in the context of tax fraud and amnesty. More recently, Fischer (2004), Feld and Matsusaka (2003) as well as Feld and Schaltegger (2002), found the amount of public services provided to be negatively related to an index of democratic control developed by Stutzer (1999). This index is used here as well, with the expectation of a positive relationship with efficiency.
- *Decentralization* (DEC): Decentralized provision of public services has an ambiguous effect on efficiency. On the one hand, it might cause a lack of human and technical resources in small units, resulting in higher cost of administration (see e.g. Crook and Sverrisson, 2001 or Smith, 1985). On the other hand, Tiebout (1956) argues that decentralization facilitates competition, which fosters efficiency. In this work, DEC is the share of cantonal expenditure that is transferred to the communities.
- *Culture* (CULT_F=1): The French- and German-speaking parts of Switzerland differ in many ways, which may well result in efficiency differences (Fischer, 2004). Thus, CULTF=1 if the canton is predominantly French speaking.
- *Size* (SIZE=1): This variable takes on the value of one if TPSP>1. A positive relationship with efficiency scores would indicate economies of scale.
- *Year of observation* (Y_2001=1, Y_2002=1, Y_2003=1, and Y_2004=1): This set of dummy variables indicates the year of observation (base year is 2000). While the test for homogeneity in Section 5.2 did not suggest rejection with regard to time, it might still be the case that efficiency increased or decreased moderately over the years.

Estimation results are displayed in Table 3. Model 1 is the comprehensive specification. While most coefficients have the expected sign, only 8 out of 17 are significant at the 90 percent level or better. In particular, FIN_POT (the index of financial potential that determines fiscal equalization payments) cannot be said to systematically lower efficiency (but see below).

However, SUBS does have the expected negative effect. Therefore, a common but rarely tested hypothesis, stating that subsidies encourage inefficiency, receives some confirmation (see e.g. Frey et al. 1994). Thus, the estimation result presented here suggests that fiscal equalization should do without earmarked payments.

INCOME and TAX show the expected negative and positive signs respectively, in line with the findings of De Borger and Kerstens (1996). However, they are not statistically significant, being highly correlated with FIN_POT. Another major contradiction to theoretical expectations is DIR_DEM, in that more democratic control seems to lower rather than increase efficiency. DEC has a positive effect on cantonal efficiency. Therefore, the negative effects emphasized by Crook and Sverrisson (2001) and Smith (1985) may be more than compensated by the positive ones due to Tiebout competition. Finally, SIZE confirms the DEA findings discussed in Table 2 in that larger cantons even perform less efficiently, possibly because citizens cannot exert as much control in them.

Table 3 Tobit estimates of efficiency scores

Variables	Exp. Sign	Model 1			Model 2				
		Coefficient	S.E.	Elasticity ^{a)}	Coefficient	S.E.	Elasticity ^{a)}		
FIN_POT	-	-5.92E-04	4.82E-04	-7.31E-02	-9.87E-04	**	2.39E-04	-1.22E-01	
SUBS	-	-3.17E-05	**	8.65E-06	-5.46E-02	-3.08E-05	**	6.06E-06	-5.31E-02
INCOME	-	-5.64E-04	6.46E-04	-7.59E-02					
TAX	+	3.39E-04	4.43E-04	4.85E-02					
TOPOGR	-	-7.04E-05	9.36E-05	-1.28E-02	-1.02E-04		8.21E-05	-1.84E-02	
IND_STRUCT	-	-5.57E-03	4.44E-03	-1.18E-02	-4.46E-03		3.88E-03	-9.42E-03	
POP_STRUCT	-	-6.58E-02	**	1.80E-02	5.08E-03	-6.49E-02	**	1.60E-02	5.01E-03
SPILL_B	+	2.88E-02	2.31E-02	1.72E-02	3.15E-02	**	1.44E-02	1.88E-02	
P_HOUSING	-	-2.40E-01	**	1.00E-01	-3.33E-01	-2.66E-01	**	8.28E-02	-3.69E-01
DIR_DEM	+	-1.82E-02	**	8.21E-03	-1.01E-01	-1.62E-02	**	7.61E-03	-9.03E-02
DEC	+/-	1.85E-02	7.54E-02	9.92E-03					
CULT_F	-	-5.12E-02	**	1.97E-02	-1.56E-02	-5.20E-02	**	1.76E-02	-1.58E-02
SIZE	?	-3.65E-03	1.89E-02	-2.00E-03					
YEAR 01	?	-2.35E-02	*	1.37E-02	-6.57E-03	-2.31E-02	*	1.38E-02	-6.46E-03
YEAR 02	?	-5.75E-02	**	1.40E-02	-1.54E-02	-5.57E-02	**	1.39E-02	-1.49E-02
YEAR 03	?	-6.10E-02	**	1.40E-02	-1.71E-02	-5.84E-02	**	1.38E-02	-1.63E-02
YEAR 04	?	-4.70E-02	**	1.41E-02	-1.31E-02	-4.44E-02	**	1.38E-02	-1.24E-02
Observation			114				114		

*,** Significant at the 90% and 95% confidence level, respectively.
^{a)}Elasticities evaluated at sample means

Model 2 excludes those explanatory variables that proved insignificant in Model 1, frequently reflecting multicollinearity problems (INCOME, TAX). Now both FIN_POT and SUBS have the theoretically expected significant negative influence on DEA efficiency. Surprisingly however, FIN_POT (elasticity -0.122) has a higher effect than SUBS (elasticity -0.0531). One would have expected earmarked transfers to have a particularly marked negative effect on cantonal performance.

With the three determinants entering the new formula of fiscal equalization (TOPOGR, IND_STRUCT, and POP_STRUCT) do have negative coefficients, only the last is statistically significant. Therefore, the 2008 reform introduces factors in the equalization formula that do not seem to have a significant influence on the cost of providing public goods. It is therefore unlikely to achieve its objective.

The positive sign of SPILL_B suggests that cantons who benefit from spillovers are more efficient than others. The negative coefficient of P_HOUSING is as expected; high cost of housing factors into the cost of public services and hence inefficiency. The negative coefficient of DIR_DEM remains puzzling. French-speaking cantons (CULT_F=1) have a lower efficiency score ceteris paribus. Finally, efficiency has a downward trend until 2003. This trend was reversed by 2004, however.

Conclusion 5: *The Swiss fiscal equalization program may well have a negative influence on cantonal efficiency. Contrary to theoretical expectations, however, earmarked subsidies do not cause this negative effect to be even more marked. Finally, reliance on exogenous factors such as population structure for determining transfer payments may be unwarranted.*

6 CONCLUDING REMARKS

The purpose of this paper was to measure efficiency in the provision of public services in the case of the 26 cantons of Switzerland and to find out whether the existing fiscal equalization program undermines incentives for good cantonal performance. The measurement tool used is Data Envelopment Analysis (DEA), which maximizes the distance between an output and an input bundle. Apart from Total Public Sector Productivity (TPSP, an indicator developed by Afonso et al., 2005), eight components of public services were distinguished. Inputs were equated to real expenditure over the years 2000 to 2004. In a second step, DEA efficiency scores were related to ‘financial potential’, which governs the Swiss fiscal equalization scheme that seeks to alleviate the disparities between cantons.

The main results are the following. First, there are no indications of economies to scale, a finding that lends support to voters’ resistance against mergers between cantons in the name of increased efficiency (voters said “No” to the proposed merger between the cantons of Geneva and Vaud in 2002). Thus, in the conflict between the views of Tiebout (1956), who emphasizes the disadvantages of large political units, and Smith (1985) as well as Crook and Sverrisson (2001), who emphasize their advantages, this evidence tends to support the Tiebout view. Second, earmarked federal subsidies (the main component of transfer payments under the fiscal

equalization program) are negatively related to cantonal efficiency, their elasticity being -0.05. 'Financial potential' (elasticity -0.12) has a similar and even stronger effect for financially advantaged cantons. Therefore, schemes designed to mitigate disparities, found unacceptable not only by politicians but citizens as well (the pertinent constitutional amendment survived a popular referendum in the case of Switzerland) may have the undesired side effect of undermining incentives for efficiency. Both cantons who are payors and recipients seek to keep their 'financial potential' low – the former because this serves to ease their burden, the latter because they expect to receive more transfer payments and subsidies. One way to achieve this objective is to produce public services at higher than minimum cost. Therefore, the equity-efficiency trade off noted by Stiglitz (1988) seems indeed to exist in the case of Switzerland.

This analysis suffers from several limitations. Above all, DEA efficiency scores constitute a very technocratic measure, being silent on the question of whether the services provided reflect the preferences of citizens. Also, some of the explanatory variables used to predict efficiency scores may not be fully exogenous. In particular, INCOME may not only influence efficiency as a taste variable but may be the (long-term) consequence of cantonal efficiency as well. In spite of these limitations, the analysis does point to side effects of programs that at least at the time of their inception had the support of citizens (as was the case of the Swiss fiscal equalization program). Yet, in the longer term, these programs may engender substantial costs to society through their deleterious effect on efficiency in the provision of public goods.

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8 APPENDIX

Table 4 Output indicators for the eight components of TPSP

Public Service	Output	Description, remarks
Administration		
Legislative, Executive	Population	Population served is taken as a proxy for administration services provided, following De Borger and Kerstens (1996).
General administration	Population	
Public safety		
Police	Population	The assumption is that all citizens have the same preferences for public safety and a similar probability of suffering from crime.
Judicature	No. delinquencies	Total annual number of delinquencies reported to police.
Fire department	No. dwelling units	The assumption is that the fire risk is the same across dwelling units.
Education		
Schooling	Weighted students	The numbers of kindergarten, primary, and secondary students are weighted using average cost.
Culture & Sport		
Culture	Urban population	Population living in towns of 10,000 and more inhabitants. The assumption is that urban dwellers are more interested in cultural activities.
Sport	No. sport events	Cantons are commissioned by the federal Department of Defence, Population, and Sports to organize sports events especially for youths.
Health		
Hospitals	No. patient cases	Case-mix adjusted number of cases.
Nursing homes	No. patient days	Patient days in retirement and nursing homes.
Transportation		
Federal motorways	Road length in km	Maintenance only.
Cantonal roads	Road length in km	Maintenance only.
Communal roads	Road length in km	Maintenance only.
Environment & Spatial planning		
Waste disposal	To. waste collected	Excludes toxic and incombustible waste.
Spatial planning	Population density, No. deaths	Population density and number of deaths for funeral output weighted by the regression coefficients as described in section on data.
Public economy		
Farming	Farming area	The assumption is that farming area serves as recreation area.
Forestry	Forest area, logging volume	The two items are aggregated using the regression coefficients as described in the section on data.

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