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Public Good Provision 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 twofold. First, it measures the efficiency in the provision of public goods by local jurisdictions applying Data Envelopment Analysis (DEA). Second, it relates efficiency scores to a fiscal equalization scheme designed to mitigate the negative consequences of Tiebout competition. The data come from the 26 cantons of Switzerland (2000-2004), a country characterized by marked federalism. Results show the equalization scheme to indeed have a negative influence on performance, resulting in an efficiency-equity trade-off (Stiglitz, 1988). However, substitution of earmarked payments by lump-sum payments as part of the 2008 reform is likely to enhance cantonal performance.

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

JEL: C14, C67, H11, H72, H83

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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 efficient use of tax revenues. Examples of efficiency measurement of public services include Drake and Simper (2003), who examined police departments in England and Welsh, Worthington and Dollery (2001), who estimated the efficiency of waste management in South Wales and 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 the Tiebout hypothesis. As to continental Europe, Afonso and Fernandes (2006), Afonso and Scaglioni (2005), De Borger and Kerstens (1996) as well as Vanden Eeckaut et al. (1993) 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 performance of Belgian local governments, while federal grants have a negative influence. At the country level, Afonso et al. (2006), comparing new EU member and emerging market states, conclude that trade openness and transparency in government have a positive but insignificant effect on efficiency, while public trust in politicians fosters inefficiency.

These studies have not taken into account one feature of federalist countries that may affect efficiency at the local level, viz. fiscal equalization schemes. Fiscal equalization is designed to reduce horizontal and vertical fiscal imbalances that often exist between lower-level jurisdictions to provide public goods. This reduction is achieved by payments from jurisdictions with above-average fiscal capacity to jurisdictions with below-average fiscal capacity. In this way below-average jurisdictions are to be enabled to produce public goods at average tax rates (Thöny, 2005). Equalization schemes exist in most countries, among them the United States, the European Union, Germany, Austria, and Switzerland – sometimes even at the community level. However, 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 jurisdictions on the receiving end may lack incentives for efficiency. The efficiency of contributing states may be undermined, too, giving rise to the well-documented 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. Aggregate output performance indicators including six major public services are constructed to calculate cantonal efficiency scores based on robust Data Envelopment Analysis (DEA). Second, calculated efficiency scores are related to the fiscal equalization scheme operated by the Swiss federal state both in its present and its new (allegedly improved) form, controlling for socioeconomic factors that also have an influence on cantonal performance.

To the best knowledge of the authors, this is the first contribution undertaking a macroeconomic efficiency measurement of public good provision in a federalist country that takes the incentive effects of a fiscal 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 described in the fourth section. The fifth section is devoted to the presentation of results of the DEA and of a Tobit model estimating the effect of the fiscal 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 Producers of Public Goods

Switzerland, a federal state with its constitution dating from 1848, distinguishes between three levels of government, viz. federal, 26 cantons[1], and approximately 2,600 communities. Public services are financed and provided at all three levels, but with differing authorities. While

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

the communities act under cantonal oversight, the cantons still constitute the backbone of the state. By article 3 of the Swiss constitution, they are responsible for all public services that are delegated neither to the federal state nor to their affiliated local authorities. Cantons are sovereign governmental entities with their own constitution and separation of power (legislative, executive, and judiciary), resulting in an extremely decentralized provision of public services.

Table 1 shows public expenditure on the 12 major service categories according to the three levels of authority. To the extent that Olson's (1969) equivalence principle applies, expenditure by an authority also means provision. According to that principle, more than 60 percent of public good provision are estimated to be controlled by the 26 cantons and their affiliated communities. However, this share varies between categories; it is particularly low for military defense and foreign relations, which are delegated to the federal state. It is highest in education and health, which also constitute two of the most important overall expenditure items.

Table 1: Functional structure of public good provision, 2004

Expenditure In CHF Million	**Federal state**	**Cantons**	**Communities**	**Total**
(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 & Internal revenue	9,411	-984	1,059	9,486
Total expenditure	**52,624**	**48,947**	**36,808**	**138,379**

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

The Tiebout (1956) hypothesis predicts a positive relationship between fiscal federalism and performance of government. Similar to a free market economy, where consumers buy from the producer offering the best performance-price ratio, citizens choose the jurisdiction

where they get the best ratio between public services provided and tax paid. In the case of Switzerland, cantonal autonomy in combination with direct democratic control through popular initiatives and referenda have resulted in considerable heterogeneity in the mode of provision. Since citizens can migrate and shift capital freely between cantons, they indeed expose them to Tiebout competition.

However, this hypothesis assumes that there are no externalities and that differences in performance are entirely due to the efficiency of administration. Externalities (spillover effects) exist if citizens from one canton cannot be prevented from using services provided by another canton without paying. They typically arise in health care, education, and culture, although 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. As to the efficiency of administration, there are disparities that are due to topographic, demographic, and socioeconomic conditions, constituting a handicap that cannot be overcome by the affected canton. Both confounding influences will be controlled for (see Section 4.1 and 4.4, respectively) when assessing the influence of Tiebout competition on cantonal performance.

2.2. Existing Fiscal Equalization Scheme

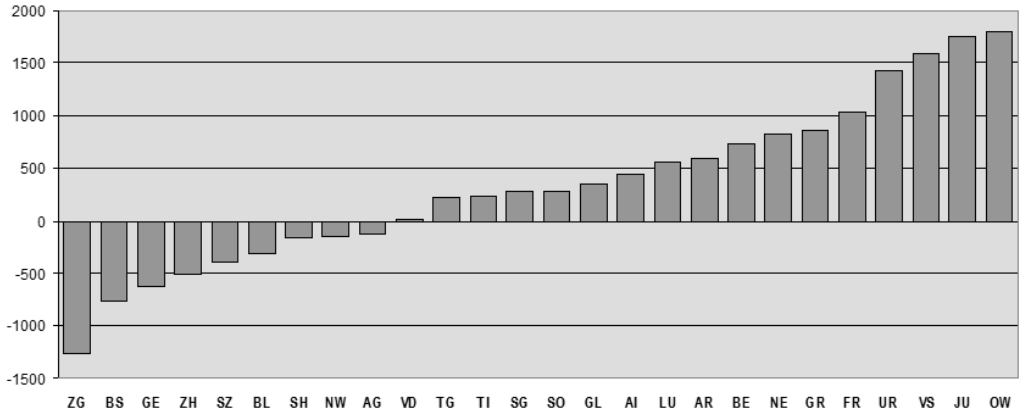
To overcome these disadvantages of fiscal federalism, Switzerland initiated a fiscal equalization program in 1959 to equalize cantonal disparities in the provision of public goods. According to an amendment of the federal constitution (article 135), cantonal disparities are to be mitigated with reference to Tiebout competition, the objective is to create a level playing field. By 2004, fiscal equalization has grown to some 1,000 CHF mn. of payments from the confederation to the cantons and another 1,500 CHF mn. between them. In relative terms, it totals almost 3 percent of cantonal and communal expenditure. The program is geared to the 'financial potential' indicator, which has four components.

Financial potential is defined to increase with

(1) *Income:* Cantonal income per capita;

(2) *Tax power:* Taxable income, weighted by the *tax burden* per capita;

Figure 1: Payments of the Swiss fiscal equalization program (2004)[a)]



Source: Federal Finance Administration (FFA)
a)For the acronyms, see footnote No. 1.

(3) *Inverse of tax burden:* Cantonal plus communal taxation as a share of *Income*;

(4) *Favorable 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. The canton of Zug contributed the maximum of some CHF 1,250 (1 CHF = 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. In comparison, the extreme values of the German equalization scheme are a maximum of some CHF 600 paid by the land of Hessen and a maximum of some CHF 1,200 CHF per capita received by Berlin. These figures illustrate the importance of the Swiss fiscal equalization scheme.

One also needs to distinguish between earmarked (almost 70 percent of total) and general payments. While general payments can be used by the canton in ways it believes to generate the highest benefit for its citizens, earmarked subsidies may result in gold plating of projects and hence inefficiency (see e.g. De Borger and Kerstens, 1996).

Wrong incentives of the fiscal equalization program could have a sizable influence on cantonal performance and national welfare. Indeed, 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). In addition, cantons that are obliged to pay into the scheme have incentives to waste their money as well. They rather spend it on idle projects than give it to other cantons. These concerns have resulted in a reform proposal that passed a popular referendum in 2006. Starting in 2008, the share of earmarked payments was to be reduced to a minimum. Equalization payments are to be governed by a new formula, which distinguishes between resource and financial disparities. Against this backdrop, this paper seeks to answer two questions:

(1) Does a fiscal equalization program as sizable as the Swiss contain incentives to provide public goods less efficiently, creating a trade-off between equity and efficiency?

(2) Does it matter whether transfer payments are earmarked or not?

3. MEASURING TECHNICAL EFFICIENCY WITH DATA ENVELOPMENT ANALYSIS

The characterization of Swiss cantons in the preceding section justifies viewing them as largely independent producers of a subset of public goods. For productivity measurement, they constitute decision making units (DMU) that transform inputs into outputs, with productivity reflecting the quality of their administration. Following Koopmans (1951), technical efficiency in the provision of public goods thus can be measured with reference to a technology set Γ,

$$\Gamma = \{(X, Y) |\ Y \leq f(X)\} \tag{1}$$

that describes the feasible set of input and output combinations (X, Y) of a production process. A DMU is called technically efficient if it lies on the boundary of Γ. On that boundary, it is not possible to produce more outputs Y for a given amount of inputs $\bar{X}$; or conversely, no smaller quantity of inputs X can produce a given output $\bar{Y}$.

There are various assumptions regarding the boundary of Γ. For simplicity we adopt those

of Shephard (1970),

$$
\begin{aligned}
Iso\ X(y) &= \{x|\ x \in X(y), \theta x \notin X(y), \forall\ 0 < \theta < 1\} \\
Iso\ Y(x) &= \{y|\ y \in Y(x), \theta^{-1} y \notin Y(x), \forall\ 0 < \theta < 1\}. \qquad (2)
\end{aligned}
$$

Here, the input and output isoquants $Iso(\cdot)$ define sections with strong and weak technical efficiency, depending on the slope of the frontier, with θ denoting a scalar by which all inputs can be reduced without leaving the feasibility set. Accordingly, θ^{-1} symbolizes the scaling-up factor for the outputs. However, the relevant technology set is almost never known in applied economic research, forcing the analyst to use observed rather than efficient input and output quantities. The pertinent methodology was developed by Farrell (1957); it has evolved into a distinction between parametric (econometric) and non-parametric (mathematical) methods (see Coelli et al. 2005 for respective overviews).

In public good provision analysis, Data Envelopment Analysis (DEA) is the most common alternative. Webster et. al (1998) argue that DEA dominates its main competitor, Stochastic Frontier Analysis (SFA) because of the following reasons:

- DEA is more flexible because no specific functional form of the transformation process needs to be specified;
- DEA does not have to rely on price data for inputs and outputs, which often is lacking in the public sector.

DEA is the preferred technique for the present investigation, in particular because of lacking information about factor prices. Public sector accounts are notorious for neglecting capital user cost, and Switzerland is no exception. The DEA version employed here is an input-orientated one. The objective is to determine an efficient frontier $\widehat{IsoX(y)}$ that is defined by the most productive DMUs. DEA amounts to solving a linear optimization problem for a particular DMU_c or canton $c = 1, ..., 26$, with an $1 \times N$ output vector y_c and a $1 \times M$ input vector x_c.

$$
\begin{aligned}
\text{Max}_{\upsilon,\nu} \quad & \upsilon' y_c \\
\text{s.t.} \quad & \nu' x_c = 1 \\
& \upsilon' Y - \nu' X \leq 0 \\
& \upsilon, \nu \geq 0.
\end{aligned} \tag{3}
$$

Here, the $26 \times N$ output matrix Y and $26 \times M$ input matrix X represent the data for all 26 cantons. Thus, let a canton optimize its outputs y_c and inputs x_c by maximizing the distance between them valued using weights υ and ν. Note that these weights relate to the universe of all cantons and can be interpreted as shadow prices. Moreover, inputs are normalized to sum up (after weighting) to 1. The inequality $\upsilon' Y - \nu' X \leq 0$ prevents outputs from increasing without bounds for a given bundle of inputs. $\widehat{Iso X(y)}$ is defined by those units for which $\upsilon' Y - \nu' X = 0$. Their efficiency score $\widehat{EFF_c}$ is 100 percent, while that of the other DMUs is given by their radial distance from the frontier.

However, the location of the efficient frontier strongly depends on the extreme DMUs (which lack comparators). One way to obtain robust DEA efficiency scores $\widehat{EFF}$ is to iteratively exclude one DMU lying on the efficiency frontier. The new frontier then assigns this DMU a so-called super-efficiency score in excess of 100 percent (Andersen and Petersen, 1993). The larger the super-efficiency of a DMU, the farther away it is from the remaining units in the technology set. Here, if this score is more than 1.5 times the distance between the 25th and the 75th percentile of all super-efficiency values, the pertinent DMU is excluded as an outlier (Thanssoulis, 1999).

In a second step, the obtained robust efficiency scores $\widehat{EFF_{ct}}$ (of cantons $c = 1, ..., 26$ in year $t = 2000, ..., 2004$) are related to a set of variables characterizing the Swiss fiscal equalization program in order to address the two research questions stated at the end of Section 2,

$$
\widehat{EFF_{ct}} = \gamma_0 + \gamma_1 X_{1,ct} + \gamma_2 X_{2,ct} + ... + \gamma_n X_{n,ct} + \varphi_{ct}. \tag{4}
$$

Tobit estimation is applied to account for the fact that scores cannot exceed 1.00 (the lower limit of 0 is less relevant because it is never binding). Specification details are given in Section 5.2 below.

4. DATA

4.1. Service categories retained

The data come from the Federal Statistical Office, covering the years 2000 to 2004. As shown in Table 1, not all categories of services listed are predominantly subject to cantonal control. Moreover, the quality of data is insufficient for some categories. Therefore, only six out of twelve are retained for this investigation, viz. (1) administration, (2) public safety, (5) education, (7) health, (9) transportation and (11) public economy (they will be renumbered 1 to 6 below). Further, in order to exclude spillovers as far as possible, only primary and secondary education (without tertiary and vocational components), private road transportation (without regional public transportation) and farming and forestry are included in the the analysis. More refined adjustments for spillovers (known to exist especially in health care) were not possible. They are controlled for in the second step Tobit estimation.

4.2. Constructing an aggregate output performance index

Since outputs of the public sector are difficult to measure, activity-based indicators serve as a substitute, in line with previous studies (see. e.g. Afonso et al., 2006). In this paper two to six indicators for each of the six retained categories – in total 22 – are selected to proxy the output of public goods provided by a canton (see Table 4 of the Appendix).

Our selection was based on two concerns: choosing the most relevant variables and making sure that they cover the years 2000 to 2004 for each canton. The relevance of the selected variables is checked with an analysis of cost drivers in the six service categories. Thus, the dependent variables are category-specific real expenditure C^j_{ct}, $(j = 1, ..., 6)$ of canton c, $(c = 1, ..., 26)$ in year t, $(t = 2000, ..., 2004)$. They are related to the output indicators $(Y^j_{k,ct}, k =$

$1, ..., K_j$ for $2 \leq K_j \leq 6$) and a time trend ($trend_t^j, t = 1, ..., 5$),

$$\begin{aligned} C_{ct}^1 &= \beta_0^1 + \beta_1^1 Y_{1,ct}^1 + \beta_2^1 Y_{2,ct}^1 + \cdots + \beta_{K_1}^1 Y_{K_1,ct}^1 + \alpha^1 trend_t^1 + \varepsilon_{ct}^1 \\ &\vdots \\ C_{ct}^6 &= \beta_0^6 + \beta_1^6 Y_{1,ct}^6 + \beta_2^6 Y_{2,ct}^6 + \cdots + \beta_{K_6}^6 Y_{K_6,ct}^6 + \alpha^6 trend_t^6 + \varepsilon_{ct}^6, \end{aligned} \tag{5}$$

Since cantons are exposed to similar shocks, error terms ε_{it}^j are likely to be correlated, calling for SURE (Seemingly Unrelated Regression Estimation). Depending on the service category, SURE confirms the relevance of the selected 22 output indicators and the correlation between the service categories (pertinent econometric results are shown in Table 5 of the Appendix). With one exception, the output indicators are positively related to cost. The negative sign of β_2^5 (number of *delinquencies*) could be the result of systematic measurement error. Some cantons report the many petty of cases (which cause little expense), while others limit their reporting to the relatively few major offenses (which cost a lot). These differences may induce a negative partial correlation between expenditure on public safety and the number of delinquencies. Furthermore, except for the two coefficients β_4^4 (*rehab clinics*) and β_6^4 (*retirement homes*), all indicators are significant at the 95 percent confidence level. Both indicators are nevertheless retained for reasons of completeness. Finally, the adjusted R^2 reaches at least 90 percent, conforming the relevance of the selected indicators.

However, including all 22 indicators is not possible in an annual DEA with 26 cantons. The retained output indicators $Y_{k,ct}^j$ need to be aggregated to form a performance index Ψ_{ct}^j for each service category ($j = 1, .., 6$) for the DEA. One therefore has

$$\Psi_{ct}^j = \sum_{k=1}^{K_j} Y_{k,ct}^j * p_k^j. \tag{6}$$

In this calculation, the problematic output indicator *delinquencies* is subjected to a linear monotone transformation such that $\widehat{Y_i} = -Y_i + r \geq 0$ (see Seiford and Zhu, 2002). As to the weighting parameters p_k^j, pertaining to the two to six output indicators per service category, there are two alternatives. One is to use the estimated β_k^j from Eqs. (5). The other is to use the shadow prices

from the j sector-specific DEA. These shadow prices reflect the marginal cost of expanding a particular service by one unit produced by an efficient DMU. For the inefficient DMUs, a radial projection onto the efficiency frontier permits to determine the pertinent shadow prices. For reasons of consistency, this alternative is retained. The results of this calculation (with Ψ_c^j values for 2004) are displayed in Table 6 of the Appendix. While the numbers are difficult to interpret in general, the entries for administration (col. 1) reflect size of the cantonal population served because the two output indicators are population and number of firms.

4.3. Input variables

The inputs are measured as real expenditure (CHF of 2000) on the six service categories. This is a widespread practice (see Afonso et al., 2006 and De Borger and Kerstens, 1996). For the categories *transportation* and *health*, only operating expenses are included (total expenditure minus investments in new infrastructure) because annual investments contain a strong transitory component.

4.4. Determinants of DEA efficiency

Recall the two research questions,

(1) Does a fiscal equalization program as sizable as the Switzerland contain incentives to provide public goods less efficiently, creating a trade-off between equity and efficiency?

(2) Does it matter whether transfer payments are earmarked or not?

The first question is investigated using three models. Model (A) relates DEA efficiency scores to the financial potential, which determines the amount of fiscal equalization between cantons. Model (B) checks whether this influence depends only on the size of the financial flows regardless of their direction. In model (C), fiscal equalization paid and received is allowed to have an asymmetric impact on efficiency. The explanatory variables are defined as follows (endogeneity issues are addressed in Section 5.2 below).

- *Index of financial potential* (F.POT): The Swiss fiscal equalization program is based on this indicator, with higher value implying less federal financial assistance (see Section 2). It is used in model (A).

- *Index of financial equalization* (F.EQ): F.EQ is a modification of F.POT. It measures the absolute value of the deviation from the value α at which no aid is contributed or received; formally, F.EQ = abs[F.POT $-\alpha$]. Note that α differs from the mean value of F.POT. The higher this index value, the larger is the amount of fiscal equalization. It is used in model (B).

- *Dummies for paying and receiving cantons* (F.GIV=1, F.REC=1): F.GIV equals 1 for cantons who are payers, while F.REC equals 1 for those who are recipients. Cantons which are neither recipients nor payers constitute the benchmark group in both cases. These variables appear in model (C).

The second research question calls for the introduction of

- *Subsidies per capita* (SUBS): This variable measures earmarked payments, which are suspected to induce a particularly high degree of inefficiency (see Section 2 again).

In addition, the following variables serve to control for other influences on cantonal efficiency scores that cannot be controlled for in the DEA but could influence efficiency scores.

- *Direct democracy* (DIR.DEM): The degree of direct democratic control (popular initiatives, mandatory referenda on expensive public projects) was already found to be relevant by Pommerehne and Zweifel (1991) in the context of tax evasion. More recently, Fischer (2004) and Feld and Matsusaka (2003) 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 within a canton has an ambiguous effect on efficiency. On the one hand, it might cause a lack of human and technical resources in small cantons, resulting in higher cost of administration (see e.g. 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.

- *Income per capita* (INCOME): This is a component of F.POT 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-wage jurisdictions face high opportunity costs when trying to monitor the efficiency of public good provision.

- *Tax burden* (TAX): This component of F.POT has additional information content as well. In line with Tiebout (1956), a canton's efficiency awareness is predicted to increase with a stronger participation in tax competition. Since a low value of TAX indicates a strong engagement in tax competition, it is hypothesized to go along with a high degree of efficiency, ceteris paribus.

- *Disparities* (TOPOGR, I.STRUCT, and POP.STRUCT): These variables reflect exogenously given disparities, which are expected to cause higher cost and hence lower efficiency in the provision of public services. They enter the new fiscal equalization formula. TOPOGR adjusts for geographic differences while I.STRUCT controls for difference of community size, the employment rate, and population density. POP.STRUCT denotes the shares of immigrants and citizens older than 80 years, with equal weights.

- *Cost of housing* (P.HOUS): The cost of housing differs substantially between cantons. It is an important component of the cost of living, which is adjusted for in the wages of public employees and hence influences the cost of providing public services.

- *Culture* (CULT.F=1): The French- and German-speaking parts of Switzerland differ in many ways, possibly also in terms of efficiency (Fischer, 2004). Thus, CULT.F=1 if the canton is predominantly French-speaking.

- *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).

5. EMPIRICAL RESULTS

This section first discusses the robust DEA efficiency scores. The assumption (to be relaxed below) is that the 26 cantons belong to the same universe, meaning that all cantons face the same circumstances in their provision of public goods. In a second step, efficiency scores are related to fiscal equalization and other socioeconomic factors of interest.

5.1. DEA Analysis

With the six output indicators derived from Eq. (6) and expenditures changing from year to year, an annual DEA for the years 2000 to 2004 can be performed. Table 2 shows the results for the year 2004. The robust efficiency scores are calculated under the assumption of constant returns to scale, indicating potential cost improvements achievable by a radial movement to a technically and scale-efficient reference point on the frontier. There are two super-efficient cases that are assigned a score of 1.00 (see Section 3 again).

Starting with the overall scores, the rural canton of Thurgovia (TG) attains 100 percent technical efficiency (score of 1.00). Two more cantons (again rural) come close, viz. Appenzell Inner-Rhodes (AI, 0.97) and Argovia (AG, 0.97). Indeed, 30 percent of all cantons have a performance score higher than 0.90. At the other extreme, Basel-City (BS) is identified as the most inefficient canton (0.63). Thus, its expenditure could have been lowered by 37 percent while still maintaining the same output level. Other urban cantons, viz. Zurich (ZH, 0.74), Geneva (GE, 0.75) already perform much better. However, differences between rural and urban cantons are not surprising. The well-known disparities caused by higher population densities and more complex industry structures, which by the way are taken into account in the fiscal equalization program, cannot be incorporated in DEA. But the second step analysis adjusts for it with three variables from the new fiscal equalization program to enable unbiased estimates of the hypotheses.

The question arises of whether the year 2004 is representative of the observation period 2000 to 2004. Figure 2 provides an answer, ranking cantons according to their five-year median values along with their estimated quartile ranges and 95 percent confidence bands. The findings of Table 2 are confirmed in that TG remains leader while BS consistently is last. While changes

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

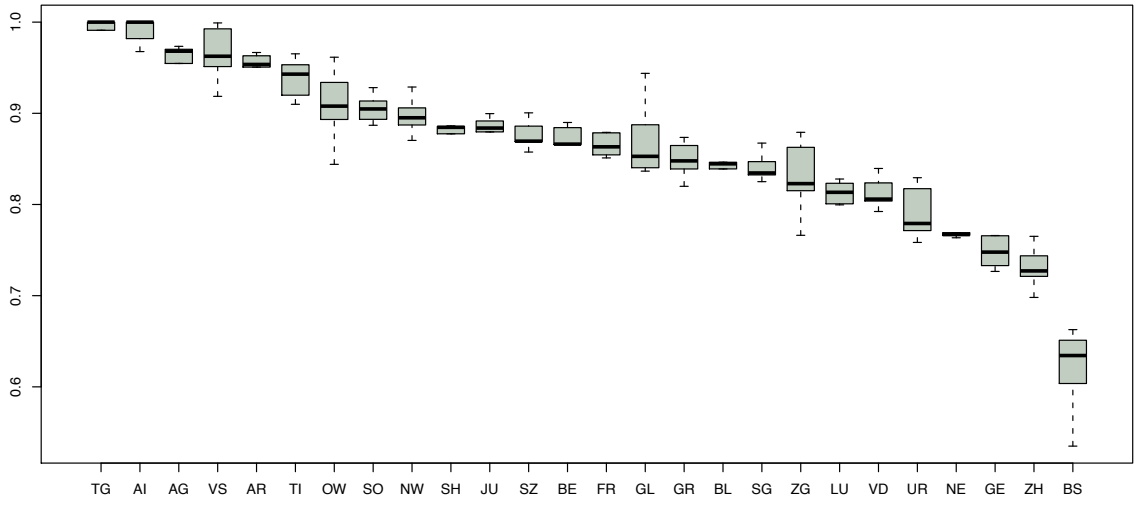
Cantons	Rank	(1-6)[a]	(1)	(2)	(3)	(4)	(5)	(6)	SD
ZH	25	0.74	0.71	0.42	0.67	0.76	0.53	0.84	0.15
BE	11	0.88	0.87	0.70	0.76	0.81	0.71	0.88	0.08
LU	20	0.82	0.64	0.74	0.91	0.63	0.67	0.79	0.11
UR	22	0.82	0.71	0.65	0.82	0.76	0.69	0.73	0.06
SZ	15	0.86	[1.00]	0.75	0.81	0.56	0.71	0.75	0.14
OW	5	0.95	0.78	0.97	0.93	0.72	0.88	0.78	0.10
NW	10	0.89	[1.00]	0.79	0.78	0.64	0.78	0.77	0.12
GL	6	0.95	0.81	0.91	0.85	0.97	0.74	0.77	0.09
ZG	16	0.85	0.95	0.51	0.69	0.81	0.69	0.92	0.16
FR	14	0.86	0.79	0.74	0.93	0.69	0.67	0.77	0.09
SO	12	0.88	0.78	0.73	0.81	0.61	0.81	0.96	0.11
BS	26	0.64	0.84	0.42	0.78	0.72	0.43	0.21	0.25
BL	18	0.85	0.68	0.70	0.84	0.69	0.62	[1.00]	0.14
SH	13	0.88	0.71	0.59	0.84	0.73	0.99	0.82	0.13
AR	8	0.93	0.64	0.91	0.86	0.93	0.61	0.98	0.16
AI	2	0.97	0.92	0.86	0.98	0.83	0.61	0.97	0.14
SG	19	0.84	0.89	0.65	0.80	0.74	0.49	0.89	0.16
GR	17	0.85	0.61	0.90	0.88	0.63	0.52	[1.00]	0.19
AG	3	0.95	0.82	0.82	[1.00]	0.59	0.95	0.91	0.14
TG	[1]	[1.00]	0.84	0.66	0.85	[1.00]	[1.00]	0.99	0.14
TI	7	0.95	0.62	0.79	[1.00]	0.85	0.78	[1.00]	0.14
VD	21	0.82	0.67	0.60	[1.00]	0.55	0.71	0.84	0.16
VS	4	0.95	0.82	[1.00]	0.96	0.76	0.77	0.78	0.10
NE	23	0.77	0.64	0.55	0.98	0.39	0.53	[1.00]	0.25
GE	24	0.75	0.42	0.38	0.91	[1.00]	0.65	0.64	0.25
JU	9	0.89	0.70	0.81	0.88	0.45	0.93	[1.00]	0.20
No. Eff.		1	2	1	3	2	1	5	
Outliers		0	0	0	0	TG	0	TI	
Mean		0.87	0.76	0.71	0.87	0.72	0.71	0.85	
Min		0.64	0.42	0.38	0.67	0.39	0.43	0.21	
SD		0.08	0.14	0.17	0.09	0.16	0.15	0.17	

[a] Mean of the six categories, normalized by the maximum value
(1)Administration, (2) Public safety, (3) Education, (4) Health,
(5) Transportation, (6) Public economy

in ranking do occur (see the overlapping interquartile ranges), they never exceed three positions. One reason for volatility over time could be investment in infrastructure. For example, ZG shows an improvement from rank 19 in 2000 to 15 in 2004 but drops to place 23 in 2003, because of spending heavily on investment without charging projects to the capital account. Yet, comparable GL with a similar degree of volatility in performance achieved a consistent improvement over the five years [from 0.84 (rank 18) to 0.94 (rank 6)]. In sum, variations over time are too limited and unsystematic to undermine the robustness of the overall ranking.

Another question of interest is whether the leader TG is the champion in all six categories

Figure 2: Overall efficiency scores, 26 Swiss cantons (2000-2004)[a)]



a)For the acronyms, see footnote No. 1.

of public service distinguished. If this were the case, Tiebout competition would unfold with full vigor. However, Table 2 shows that TG has a low efficiency score in public safety (0.66). Conversely, last-ranked BS does attain an average value in administration (0.84), permitting cantonal government to cater to voters especially interested in administrative services. Moreover, low overall scores do not necessarily go along with high standard errors across the six categories (see last column of Table 2). Bottom-ranked BS has a high standard error of 0.25 while UR with rank 23 has one of only 0.06. Thus, small and homogenous UR can survive Tiebout competition since neighboring (more urban) LU has twice as much variation [SD 0.11], while its rank is almost the same. In sum, Tiebout competition is limited even in a country as markedly federalist as Switzerland.

In a federal state, another major issue is centralization vs. decentralization. In the case of Switzerland, the debate has been focusing on education (see Barankay and Lockwood, 2006). Lack of coordination between the cantons has been cited as a reason for the rather mediocre performance of the Swiss educational system in the PISA study (OECD, 2006). However, these criticisms might be overstated. The average performance score for education (3) is 0.87 (SD 0.09). This beats the score of 0.76 (SD 0.14) for public administration (1), which is generally believed to perform well in international comparison.

5.2. Estimation of the Determinants of DEA Efficiency

Next, it is of interest to see whether fiscal equalization has an influence on the efficiency scores of the 26 cantons over the years 2000 to 2004. In total, 130 observations (26*5) are available for estimating Eq. (4) of Section 3. Disparities in the provision of public goods are reflected by the indicators discussed in Section 4.4.

Estimation results for the three models outlined in Section 4.4 are displayed in Table 3, after performing tests for endogeneity, heteroscedasticity, and nonlinearity. Fiscal equalization could be endogenous to efficiency because highly efficient jurisdictions are made to contribute to the program. However, a Hausman test does not suggest rejection of the exogeneity assumption. Heteroscedasticity is not a problem either according to a Breusch-Pagan test. Finally, linearity need not be rejected with the exception of SUBS2, TAX2 and POP.STRUCT2. Several interaction terms proved significant, too; their inclusion does not markedly affect parameter estimates, however. Estimation results turn out to be robust for the three models. Most of the variables have expected signs and are significant at the 90 percent confidence level or better.

In model (A), a negative sign is obtained for F.POT. Use of index of financial potential that determines fiscal equalization payments therefore seems to lower efficiency systematically (elasticity -0.7) after controlling for exogenously given disparities and other variables affecting the cost of public good provision. Thus, cantons with high financial potential may have an incentive to underperform. In model (B), the absolute value of payments enters with F.EQ. Not surprisingly, F.EQ has a significantly negative sign too, suggesting that fiscal equalization as such lowers technical efficiency in the provision of public goods. Finally, model (C) indicates that paying cantons (elasticity -0.084) are more influenced than receiving cantons (elasticity -0.024) with regard to efficiency.

In sum, the evidence of Table 3 provides an answer to question (1) of Section 2 by supporting the notion that fiscal equalization undermines cantonal efficiency in Switzerland for both receivers and payers, but even more for payers, who are the cantons with high financial potential. This difference is intuitive because payers have more reason to respond to fiscal equalization with inefficiency than receivers. Expecting no benefit from redistribution, they

rather waste their money than to give it to financially disadvantaged cantons. Thus, any public good with a positive net benefit is provided, whereas only those with above-average net benefits contribute to the canton's technical efficiency. Being financially constrained, receiving cantons want to ensure that their most productive projects are financed; they extend this list only in order to justify their need for redistribution. While estimated elasticities are below one throughout, fiscal equalization in the case of Switzerland does give rise to the equity-efficiency trade-off described Stiglitz (1988).

Question (2) of Section 2 asks whether earmarked federal subsidies (SUBS) have an especially strong (negative) effect on cantonal efficiency. Whereas general payments can be used by the canton where it believes to generate the highest benefit for its citizens, earmarked subsidies may result in gold plating of projects and hence inefficiency. Indeed, Table 3 shows SUBS to have a negative sign in all three models with estimated elasticities between -0.2 and -0.3. Therefore, subsidies may encourage inefficiency, as claimed in the Swiss case e.g. by Frey et al. (1994). Therefore, the new equalization formula of 2008 which minimizes earmarked payments has the potential to reduce technical inefficiency in the provision of public goods compared to its predecessor.

Some of the other explanatory variables are of interest as well. Foremost, DIR.DEM and DEC, which capture two unique features of Switzerland, contradict theoretical expectations. The negative sign of DIR.DEM suggests that direct democratic control lowers rather than increases technical efficiency. This seems to contradict the findings of Fischer (2004) as well as Feld and Matsusaka (2003), who however studied the amount of public services provided rather than technical efficiency. Still, lower amounts can go along with lower efficiency if direct democracy should mainly delay (notably through referenda) planning that is "on target" in terms of efficiency. On the other hand, decentralization has the expected effect in that the coefficient of DEC is positive throughout, confirming Barankay and Lockwood (2006) who examined the impact of decentralization on productive efficiency in public education. The negative effects emphasized by Smith (1985) apparently are more than compensated by the positive ones due to Tiebout competition, which however are subject to diminishing marginal returns (see the

Table 3: Tobit estimates of DEA efficiency scores, 2004

	Model (A)[a)]			Model (B)[a)]			Model (C)[a)]		
Variables	Coef		Elasticity[b)]	Coef		Elasticity[b)]	Coef		Elasticity[b)]
F.POT	-5.8E-03	***	-7.0E-01						
F.EQ				-7.6E-04	***	-3.8E-02			
F.GIV							-2.1E-01	*	-8.4E-02
F.REC							-2.8E-02		-2.4E-02
SUBS	-1.6E-04	***	-2.7E-01	-1.8E-04	***	-3.0E-01	-1.3E-04	***	-2.2E-01
DIR.DEM	-3.0E-01	***	-1.7E+00	-7.1E-02	***	-3.9E-01	-1.4E-01	***	-7.9E-01
DEC	2.0E+00	**	1.1E+00	3.3E+00	***	1.7E+00	2.9E+00	**	1.5E+00
INCOME	-2.8E-04		-3.7E-02						
TAX	-5.6E-03	***	-7.9E-01	-6.4E-03	***	-9.0E-01	-7.7E-03	***	-1.1E+00
TOPOGR	-1.4E-04	**	-2.4E-02	-6.2E-06		-1.1E-03	-5.7E-05		-1.0E-02
I.STRUCT	-3.3E-01	***	-7.2E-01	-2.3E-01	***	-5.0E-01	-2.3E-01	***	-4.8E-01
POP.STRUCT	-3.1E-01	***	-5.3E-01	-2.7E-01	***	-4.8E-01	-2.6E-01	***	-4.6E-01
P.HOUS	-6.3E-01	***	-8.5E-01	-6.2E-01	***	-8.4E-01	-6.5E-01	***	-8.9E-01
CULT.F	-6.0E-02	***	-1.8E-02	-4.1E-02	***	-1.2E-02	-4.0E-02	***	-1.2E-02
SUBS2	2.3E-08	***	8.8E-02	1.5E-08	***	5.6E-02	1.3E-08	***	5.0E-02
TAX2	3.1E-05	***	4.8E-01	3.2E-05	***	4.9E-01	3.9E-05	***	6.0E-01
POP.STRUCT2	7.9E-02	***	2.7E-01	6.3E-02	***	2.1E-01	5.8E-02	***	2.0E-01
DEC2	-5.0E+00	***	-1.1E+00	-5.0E+00	***	-1.1E+00	-5.4E+00	***	-1.2E+00
SUBS:F.POT	1.2E-07		1.4E-02						
SUBS:F.EQ				1.1E-06	***	7.7E-02			
SUBS:F.GIV							2.1E-05		5.9E-03
SUBS:F.REC							2.3E-05		3.0E-02
F.POT:DIR.DEM	1.3E-03	***	6.4E-01						
F.GIV:DIR.DEM							4.0E-02	**	6.9E-02
F.REC:DIR.DEM							2.8E-05		9.3E-05
DIR.DEM:DEC	4.2E-01	***	8.9E-01	1.2E-01	***	2.6E-01	2.9E-01	***	6.2E-01
I.STRUCT:P.HOUS	2.9E-01	***	6.5E-01	2.0E-01	***	4.5E-01	2.0E-01	***	4.5E-01
Observation	114			114			114		
L-Likelihood	384.1			374.9			372.2		

*,**,*** Significant at the 90%, 95% and 99% confidence level, respectively.
[a)] Time dummies for the years 2004, 2003, 2002 and 2001 are not shown
[b)] Elasticities evaluated at sample means

negative coefficient of DEC2).

In addition, TAX shows the expected negative sign, suggesting that cantons with a low tax burden exhibit higher performance, a state of affairs conducive to strong Tiebout competition. However, the positive sign of the quadratic term points to a rapidly diminishing effect as soon as the tax burden starts to increase, with the critical value of 90.32 in model (A) and 100 in model (B), respectively (the average tax burden of Switzerland is set to 100). The positive sign of TAX found by De Borger and Kerstens (1996) therefore also holds for Switzerland as soon as it exceeds the average. Thus, both extremely low and high tax burdens cause efficiency gains,

because of tax competition on the one hand and because of increasing monitoring by citizens on the other.

Finally, it is of interest for policy to know whether the determinants entering the new fiscal equalization formula (TOPOGR, I.STRUCT, and POP.STRUCT) to adjust for resource disparities are relevant or not. The three variables are negatively related to DEA efficiency scores regardless of model specification. Therefore, the 2008 reform is likely to achieve its objective because it introduces exogenous factors in the equalization formula that seem to have a significant influence on the heterogeneity of public good provision. Finally, the negative coefficient of P.HOUS shows that the cost of housing factors into the cost of public services and hence inefficiency. Since it is largely exogenous, it could also be included in the fiscal equalization formula.

6. CONCLUDING REMARKS

The purpose of this paper was to measure efficiency in the provision of public services applying Data Envelopment Analysis (DEA), which maximizes the distance between an output bundle and an input bundle. The country analyzed is Switzerland, which is characterized by a high degree of federalism permitting Tiebout competition on the one hand and a sizable fiscal equalization program on the other. DEA shadow prices serve to derive the weights for aggregating the six public service categories into an overall output indicator for the 26 cantons, while inputs are equated to their real expenditure over the years 2000 to 2004. In a second step, DEA efficiency scores are related to the indicator 'financial potential' which governs the Swiss fiscal equalization scheme designed to alleviate disparities between cantons.

The main results are the following. First, efficiency scores indicate better performance of small rural cantons than of urban ones and are robust over the five years investigated. A comparison over the six service categories further shows that cantons with a high overall performance do not automatically outperform in all of them, preventing any one of them from becoming dominant in Tiebout competition. Second, financial equalization is negatively related to cantonal efficiency, with an especially marked effect on payers. Schemes designed to mitigate disparities

that are deemed unacceptable not only by politicians but the citizenry as well (the pertinent constitutional amendment survived a popular referendum in the case of Switzerland) may thus have the undesirable side effect of undermining incentives for efficiency. Jurisdictions who are payers and receivers both 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 notably by producing 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. Third, earmarked federal subsidies (the main component of transfer payments prior to the 2008 reform) are negatively related to cantonal efficiency as well. Substitution of these earmarked payments by freely disposable lump-sum ones as part of the new equalization program implemented in 2008 is therefore likely to enhance cantonal performance.

This analysis suffers from several limitations. Above all, DEA efficiency scores constitute a 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 the long term. In particular, INCOME possibly not only influences efficiency as a taste variable but could be the consequence of cantonal efficiency as well. In spite of these limitations, the analysis not only identifies the equity-efficiency trade-off that federally organized countries (such as Switzerland) face when implementing a fiscal equalization scheme but also provides guidance on how to structure it in terms of earmarked and freely disposable payments.

APPENDIX

Table 4: Output indicators for the investigated six governmental activities

Public Service	Output	Description, remarks
Administration		
Legislative, Executive	β_1 Population	Population served and number of firms serve as proxies for administration services provided.
General administration	β_2 No. firms	
Public safety		
Police	β_1 Population	The assumption is that citizens have the same preferences for public safety and a similar probability of suffering from crime.
Judicature	β_2 No. delinquencies	Total annual number of delinquencies reported by police.
Fire department	β_3 No. dwelling units	The assumption is that the fire risk is the same across dwelling units.
Education		
Kindergarden	β_1 No. students	The numbers of kindergarten, primary, secondary and high school students serve as indicators of output values. Quality of education is neglected because of lacking annual data.
Primary education	β_2 No. students	
Secondary education	β_3 No. students	
High school education	β_4 No. students	
Health		
Hospitals (specialized)	β_1 No. patient cases	Case-mix adjusted number of cases serve as a severity-adjusted output.
Hospitals (primary)	β_2 No. patient cases	
Hospitals (psychiatric)	β_3 No. patient days	The output of rehabilitation and psychiatric clinics, nursing homes, and retirement homes is measured by the number of patient days. No quality adjustment was possible because of lacking data.
Rehab clinics	β_4 No. patient days	
Nursing homes	β_5 No. patient days	
Retirement homes	β_6 No. patient days	
Transportation		
Cantonal roads	β_1 Road length	Maintenance only.
Communal roads	β_2 Road length	Maintenance only.
Road utilization	β_3 No. cars	Registered number of cars is used as an utilization indicator.
Public economy		
Farming	β_1 Farming area	The assumption is that farming areas serve recreation purposes.
	β_2 Mountain area	The share of mountain area and organic farming area adjusts for differences in quality.
	β_3 Organic area	
Forestry	β_4 Forest area in	The assumption is that forest areas serve recreation purposes.

Table 5: Seemingly unrelated regression results for six public service categories [a)]

Coefficients	(1)		(2)		(3)		(4)		(5)		(6)	
β_1	9.74E+04	***	-7.18E+04	**	1.25E+08	***	1.61E+05	***	3.17E+04	***	2.50E+00	***
	2.04E+04		2.22E+04		1.91E+07		2.42E+04		4.83E+03		9.33E+02	
β_2	1.55E+05	***	1.76E+05	***	2.19E+08	***	3.07E+05	***	2.17E+04	***	7.80E+03	***
	2.14E+04		5.19E+04		1.35E+07		2.26E+04		5.85E+03		1.82E+03	
β_3	-		1.69E+05	**	5.79E+07	***	4.78E+04	***	6.17E-01	***	1.29E+04	***
			5.49E+04		1.28E+07		9.75E+03		3.10E+03		2.56E+03	
β_4	-		-		7.06E+07	***	3.98E+03		-		1.67E+04	***
					1.16E+07		1.08E+04				1.88E+03	
β_5	-		-		-		1.08E+05	**	-			
							3.93E+04					
β_6	-		-		-		2.38E+04		-		-	
							1.72E+04					
t_04	5.46E+03		2.94E+04		2.68E+07		134602.007		1.14E+03		-1.55E+04	
t_03	2.15E+04		2.46E+04		2.47E+07		136235.231		3.23E+03		-4.07E+01	
t_02	1.46E+04		9.70E+03		2.04E+07		140580.413		1.51E+03		-9.06E+02	
t_01	1.99E+04		4.20E+03		7.50E+06		8025.43831		1.50E+03		-1.59E+01	
Adj. R^2	0.93		0.90		0.98		0.96		0.92		0.99	
Observations	130		130		130		130		130		130	
Correlation matrix of the residuals												
(1)	1.00		0.20		0.03		0.37		-0.17		0.03	
(2)			1.00		0.81		0.46		0.48		0.09	
(3)					1.00		0.41		0.53		0.05	
(4)							1.00		0.09		-0.15	
(5)									1.00		0.17	
(6)											1.00	

[a)] The six categories are (1) Administration, (2) Public safety, (3) Education, (4) Health, (5) Transportation, (6) Public economy, standard errors in parentheses, time dummies not shown.

,* Significant at the 95% and 99% confidence level, respectively

Table 6: Output performance indicators Ψ_i^j, 26 Cantons (2004)

Cantons	(1)	(2)	(3)	(4)	(5)	(6)
ZH	804351	609182	1438309	2414338	293337	182691
BE	608731	467307	1018589	2279872	270257	535600
LU	226021	160632	534219	490410	84259	187310
UR	22354	16503	49531	39184	12713	26513
SZ	87616	61522	175165	128367	37009	73474
OW	21130	17194	46818	33907	11161	34362
NW	28856	17994	48612	35418	10613	20764
GL	25754	19353	51962	61451	10999	29547
ZG	128873	47613	134137	132750	27843	31162
FR	160165	113271	363600	343419	75380	180878
SO	157621	112625	312784	269547	65085	85709
BS	123028	104393	232726	634082	31674	1302
BL	169043	120690	383400	317776	62031	58940
SH	47015	34727	96062	113555	31302	36222
AR	33668	24723	74755	99397	17765	43370
AI	10082	7635	29755	15113	4366	24714
SG	292344	208803	620278	668789	108448	205445
GR	120802	130689	221249	300494	97956	306163
AG	360075	255663	858094	691775	145986	146288
TG	148445	105537	332003	360721	71424	117408
TI	220732	185993	420807	654548	100196	84566
VD	413159	327087	986906	1411360	188657	274138
VS	183488	174242	399383	459095	134423	138802
NE	106986	80628	270524	284766	44079	91707
GE	288564	204038	635494	1508138	106019	24811
JU	44022	31404	95142	121188	29632	106580

(1) Administration, (2) Public safety, (3) Education,
(4) Health, (5) Transportation, (6) Public economy

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