

Technical efficiency and institutional variables

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1. INTRODUCTION

In a paper on the measurement of technical efficiency at collecting household waste, we showed that there are great differences in performance between Swiss municipalities of more than 5,000 inhabitants (BURGAT and JEANRENAUD [1992]). These performances range from 100% (the "efficient" municipality at the top of the ranking) to 22%, or from 100% to 35%, depending on the method used.

In the model used, only the variables usually found in a production function were selected, although we added one environmental variable: the average distance from the collection point to the disposal site.

After a brief reminder of two methods that play an important role in the problems relating to technical efficiency and of the results to which they lead, we introduce some new, so-called "institutional" variables in order to determine their indirect influence on the degree of technical efficiency.

2. MEASUREMENT OF TECHNICAL EFFICIENCY

There are various methods of determining the degree of technical efficiency (DTE) of a public or private service provision, i.e. the ratio of its actual production to the production deemed ideal under its operating conditions (inputs and environment). It is thus a number between 0 and 1. The degree of technical efficiency is often expressed as a percentage.

The ideal output corresponding to given inputs and a given environment is found at what is called the production frontier. The latter may be constructed by parametric or non-parametric methods. Among those in the former category, mention should be made of the SOLS method (Shifted Ordinary Least Squares) and among those of the second category, of the FDH method (Free Disposal Hull). When FDH is applied, the production frontier, in the case of one input and one output, looks like a staircase (see BURGAT and JEANRENAUD 1992, p. 9).

The main advantage of SOLS is that, in principle, there is only one efficient municipality (with a degree of 1.00), all the others being inefficient. On the other hand, the FDH method draws a distinction between two degrees of efficiency, one in terms of

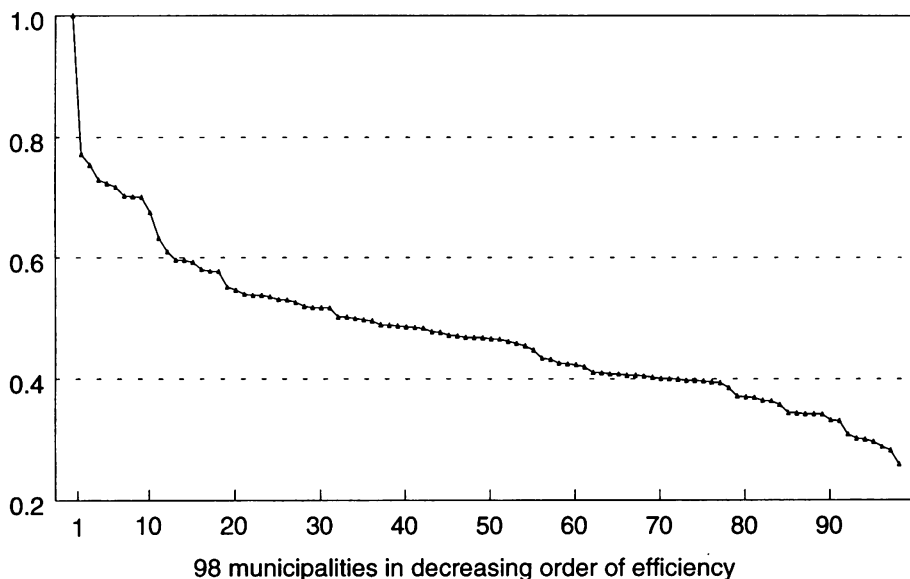
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input, the other in terms of output. The proportion of efficient municipalities is generally high, some being genuinely efficient, others being so by default. The SOLS method, in contrast, requires the more or less arbitrary choice of a production function and we have to compare a given municipality with an efficient municipality that is almost always potential. The FDH method, in contrast, draws comparisons between real municipalities.

The data were collected by means of a questionnaire survey of all Swiss municipalities with more than 5,000 inhabitants. The information obtained concerns the services provided (in terms of quantity and quality), the resources utilized (equipment and labour), the environmental characteristics and various institutional variables. Of the 196 questionnaires sent out, 98 usable replies were obtained.

We used a Cobb-Douglas production function. The production frontier was obtained by the SOLS method, which allowed us to calculate the degrees of technical efficiency. The dependent variable is the quantity of waste collected annually in metric tonnes; the independent variables are the production factors capital (vehicle capacity in m^3) and labour (number of hours worked annually by operating and administrative personal), the quality of the service measured by collection frequency and, finally, the average distance to the disposal site – the only environmental variable that proved significant. The figure below shows the degrees of efficiency of the 98 municipalities.

Fig. 1: Degree of technical efficiency



3. SERVICE ARRANGEMENT AND TECHNICAL EFFICIENCY

3.1. *Service arrangement*

We shall examine the influence of the different arrangements for providing public services adopted by the municipalities on their performance at collecting household waste. The arrangement is described by means of three institutional variables :

- the mode of service delivery (see SAVAS 1987);
- the financing mechanism;
- single or multiple service producers for the same service on the municipality's territory, but in different areas.

The hypothesis is that a link exists between the arrangement and technical efficiency. It should be noted that the more the arrangement selected by the municipality allows competition to work, the more a high degree of technical efficiency can be expected.

3.2. *Institutional variables*

a) Mode of service delivery

There are numerous ways of providing public services: municipal service, intergovernmental agreement, contracting out, purchasing the service from another local authority, franchising, self-service and free market forces. The characteristics of these different modes of service provision and their advantages and disadvantages are well-known [see HATRY (1983), SAVAS (1979a) and (1979b), JEANRENAUD (1988) and SCHWAB and CHRISTE (1990)].

In the case of a natural monopoly, the only way to create a competitive situation is to get the potential suppliers to compete when the contract is concluded. Competitive tendering allows the municipality to select the firm which undertakes to provide the service in conformity with the specifications and at the lowest cost. The provider enjoys a monopoly situation, which is nevertheless threatened to the extent that the contract is of limited duration. It should be observed that even in the case of municipal production, it would be possible to exert a certain amount of pressure on the producer by threatening to create a competitive situation. It would suffice to organize periodically an invitation to tender in order to decide whether or not it is advisable to replace public production by a government contract or franchise.

As far as we are concerned, none of the municipalities that took part in the survey granted a franchise to a private company for the collection of household waste and all the associations of municipalities contract out the service. Finally, three modes of service delivery were found among the municipalities which participated in the survey:

- municipal service;
- contracting out (by a municipality);

- intergovernmental agreements with contracting.

The information obtained from the survey does not tell us whether the contract was concluded after an invitation to tender or simply by mutual agreement. Nor do we know whether the waste collection producers perceive the threat of competition.

In order to describe the modes of provision, we introduced a discontinuous variable which may take three values corresponding to the three categories: municipal service (MS), contracting out by the municipality (CO) and intergovernmental agreement with contracting (IAC). Two dummy variables B_1 and B_2 suffice to specify these three categories.

MS: $B_1 = 0$, $B_2 = 0$

CO: $B_1 = 1$, $B_2 = 0$

IAC: $B_1 = 0$, $B_2 = 1$

b) Financing mechanism

The cost of collection is financed by general revenues or by a user charge which may be either lump sum or proportional to the quantity of waste (sale of bags). At the time the survey was conducted, only a few municipalities had opted for a proportional charge. Therefore no distinction will be drawn between a lump sum and a proportional charge. Some municipalities have adopted a user charge that covers only part of the expenditure, the balance being financed by general revenues. We assumed that mixed financing was equivalent to a user charge.

The dummy variable introduced, B_3 , will take the value 1 in the event of financing by general revenues and the value 0 where a user charge is involved. The object is to detect whether there is a relationship between the way in which the service is financed and the authorities' desire to ensure efficient management.

c) Single or multiple service producers

A fourth dummy variable, B_4 , will take the value 1 when there is competition and the value 0 in the opposite case. Here, competition only means that the service is provided by more than one firm to the households of a municipality (or association of municipalities). As the firms do not normally serve the same areas, they do not compete directly. However, they are potential competitors for each other. The municipal authorities thus have a basis of comparison with which to judge the efficiency of the firms in question. A firm that turns out to be less efficient than the others should feel the threat of its contract not being renewed.

3.3. Hypotheses

The hypotheses that guided us in choosing a model for detecting the influence of the institutional variables on the performances of the various municipalities are as follows:

1. The principal factor that explains why a municipality should be more or less efficient is the existence or non-existence of the pressure of competition. Seen from this point of view, contracting out must be more efficient than municipal production.
2. The conditions under which potential contractors are made to compete are more easily met with an intergovernmental agreement than in a municipality operating alone, as there is less pressure to choose a local supplier in the former case.
3. The municipalities which finance waste collection by a user charge are more concerned about good management than the authorities which use a tax and, consequently, are more efficient.

3.4. Influence of the institutional variables on the degree of technical efficiency

We regressed the degree of technical efficiency, DTE, on the dummy variables B_1 , B_2 , B_3 and B_4 .

$$DTE = \beta_0 + \beta_1 B_1 + \beta_2 B_2 + \beta_3 B_3 + \beta_4 B_4 + \epsilon \quad (1)$$

ϵ being the usual error term.

The average of the degree of efficiency of each of the twelve categories (three delivery systems, two financing mechanisms, and single or multiple service producers) is given either by the term β_0 or by a sum of coefficients of the regression equation, including β_0 .

In the case of municipal production, a user charge, and a single producer on the municipality's territory, we have

$$E [DTE / B_1 = B_2 = B_3 = B_4 = 0] = \beta_0 ,$$

where E denotes the mathematical expectation.

If the municipality sub-contracts, uses the general revenues for financing, and if waste collection is carried out by several firms, we have

$$E [DTE / B_1 = 1, B_2 = 0, B_3 = B_4 = 1] = \beta_0 + \beta_1 + \beta_3 + \beta_4$$

As a general rule, it is possible to draw up the following table:

Table 1: Average degree of technical efficiency

		municipal service	contracting out (one municipality)	intergovernmental agreement with contractors
user charge	one producer	β_0	$\beta_0 + \beta_1$	$\beta_0 + \beta_2$
	multiple producers	$\beta_0 + \beta_4^*$	$\beta_0 + \beta_1 + \beta_4$	$\beta_0 + \beta_2 + \beta_4$
general revenues	one producer	$\beta_0 + \beta_3$	$\beta_0 + \beta_1 + \beta_3$	$\beta_0 + \beta_2 + \beta_3$
	multiple producers	$\beta_0 + \beta_3 + \beta_4^*$	$\beta_0 + \beta_1 + \beta_3 + \beta_4$	$\beta_0 + \beta_2 + \beta_3 + \beta_4$

* This case does not exist

The reference category is municipal service with a user charge (β_0). All the other coefficients represent variations on this basic category. Since the coefficient β_4 proved insignificant at 10% in all the cases envisaged, we eliminated variable B_4 . We obtained the most significant results by selecting all the municipalities in which the population served (hereafter “population” will always be used to mean “population served”) is less than 12,500 inhabitants. The values of the regression coefficients, of the standard errors and the corresponding significant levels are shown in table 2.

Table 2: Results of the regression for municipalities with a population of less than 12,500

independant variable	coefficient (%)	std. error	t-value	sig. level
Constant	43.776760	2.948927	14.8450	0.0000
B ₁	6.021601	2.438392	2.4695	0.0204
B ₂	30.012765	5.339977	5.6204	0.0000
B ₃	-10.345611	2.786734	-3.7125	0.0010

R-SQ. (adj.) = 0.7241

In a municipality, switching from municipal service to contracting out raises the degree of efficiency by, on average, 6.0 points out of 100. Intergovernmental agreements with contracting have an average degree of efficiency 30.0 points higher than that of municipal service. This result must be interpreted cautiously given the low number of municipalities concerned. The municipalities which introduced a user charge instead of drawing on the general revenues have an average efficiency 10.3 points higher. In the most favourable case – intergovernmental agreements with contracting, and a user charge – the average degree of efficiency is 73.8%. In the most unfavourable situation – municipal service, financed by general revenues – the average degree of efficiency amounts to 33.4%. Thus hypothesis 1, 2 and 3 are verified when the population is less than 12,500.

Regarding municipalities whose population served is equal to or higher than 12,500, the explanatory power obtained with the same regression equation is low. A single coefficient, β_1 , in addition to the constant term β_0 , is significant at 10%. The fact that municipalities group together in order to contract out the service does not significantly improve technical efficiency. This result may appear surprising at first sight. Indeed, if intergovernmental agreement with contracting considerably improves efficiency when the population is small, why does the same not apply when it is large? One of the possible explanations is that the large municipalities are able, firstly, to make more rational use of their equipment and manpower and, secondly, to take considerable advantage of economies of scale.

It will be noted that we did not deem it advisable to correct the degrees of technical efficiency in order to take account of the influence of the institutional variables, unlike PERELMAN and PESTIEAU (1988), for example. In fact, the new values thus obtained no longer represent a measure of *technical* efficiency. We simply sought to detect the influence of the institutional factors on technical efficiency.

As we have seen, the regression coefficients of equation (1) are interpreted as variations of averages relating to the degrees of efficiency when switching from one category to another; β_0 corresponds to the basic category (see table 1). The significant variations are immediately detected. This approach has indisputable theoretical and practical advantages over the use of tests relating to the differences of averages of the various categories taken two by two.

The number of observations is not sufficient to determine the role of the mode of financing for *each* of the modes of service delivery.

4. CONCLUSIONS

The hypothesis which holds that contracting out is more efficient than municipal service was confirmed, but more clearly so when the population served is small. We ascertained that in the medium-sized and large municipalities, contracting out improves the partial productivity of the capital factor (by 5-10%) and that of the labour factor (by about 20%).

The fact that sub-contracting is more efficient when the contract is concluded by an association of municipalities rather than by one municipality on its own is confirmed only for the small municipalities but must be envisaged with caution given the small number of municipalities concerned. In the large municipalities there appears not to be any significant difference between sub-contracting done on behalf of one municipality alone or of an association.

There are several possible explanations for the difference between the degrees of efficiency when switching from a municipal service to contracting out: additional cost due to bureaucratic inefficiency, the opportunity the sub-contractor has of utilizing the production factors more rationally, or economies of scale. The available data do not allow the role of each of the above-mentioned causes of inefficiency to be determined.

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RESUME

L'influence des variables institutionnelles sur les degrés d'efficacité technique dans la collecte des déchets ménagers est obtenue à l'aide d'une régression portant sur des variables binaires. L'analyse concerne les communes suisses de plus de 5'000 habitants. Le degré d'efficacité moyen augmente de manière significative (à 5%) quand une commune sous-traite le service au lieu de le produire elle-même. Les autres variables institutionnelles (association de communes, mode de financement, un ou plusieurs producteurs) n'exercent une influence significative que dans le cas des municipalités de faible taille.

SUMMARY

The influence of institutional variables on the degree of technical efficiency at collecting household waste is obtained using regression involving dummy variables. The analysis concerned Swiss municipalities with more than 5,000 inhabitants. The mean degree of efficiency increases significantly (at 5%) when a municipality sub-contracts the service instead of producing it itself. The other institutional variables (intergovernmental agreement, financing mechanism, multiple service producers) has a significant influence only in small-sized municipalities.

ZUSAMMENFASSUNG

Der Einfluss der institutionellen Variablen auf die technische Effizienz in der Haushaltsabfallsammlung wird dank einer Regression mit binären Variablen erreicht. Die Untersuchung wurde in den Schweizer Gemeinden mit mehr als 5'000 Einwohnern durchgeführt. Der durchschnittliche Effizienzgrad nimmt signifikant zu (5%-Signifikanzniveau), wenn eine Gemeinde die Dienstleistung nicht selber durchführt, sondern an einen Subunternehmer vergibt. Die anderen institutionellen Variablen (Zweckverband, Finanzierungsart, ein oder mehrere Produzenten) haben nur in kleinen Gemeinden einen bedeutenden Einfluss.