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Public vs private production efficiency: A theoretical and empirical comparison

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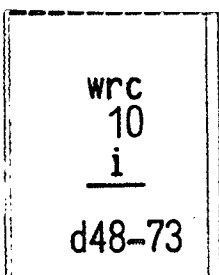
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PUBLIC vs PRIVATE PRODUCTION
EFFICIENCY: A THEORETICAL AND
EMPIRICAL COMPARISON

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DISKUSSIONSBEITRÄGE

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Preliminary Draft

Comments welcome

PUBLIC vs PRIVATE PRODUCTION EFFICIENCY: A THEORETICAL
AND EMPIRICAL COMPARISON

ABSTRACT

The relative efficiency of private and public production of a public service (in particular households' refuse collection) is studied using the theory of property rights and the economic theory of bureaucracy. Both kinds of institutional organization of production result in inefficiencies if realistic conditions are considered. The empirical analysis of refuse collection of 103 Swiss cities shows evidence that private production may be more efficient. If refuse collection were turned over to private enterprise on the basis of some such evidence, the government's task does not end but rather is shifted, only. It has to find ways and means to set the conditions such that private producers function efficiently in the long run. In particular, it must insure that competitive pressure on costs persists.

PUBLIC vs PRIVATE PRODUCTION EFFICIENCY: A THEORETICAL
AND EMPIRICAL COMPARISON

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I. INTRODUCTION

The purpose of this article is to make an empirical comparison of public (municipal) production of an urban service with the production of the same service by private firms. Such a comparison must be based upon a theoretical analysis in order to be able to correctly approach the estimation problem and to derive meaningful conclusions from the empirical evidence.

In particular, the paper's intention is to

- (a) make a contribution to a research area in which economics and public policy analysis have so far made comparatively little effort¹⁾;

AUTHORS' NOTE: The authors are indebted to many people in industry and government of various Swiss cities for granting interviews and responding to mailed questionnaires, as well as for providing the basic data for this study. They are particularly grateful for the useful advice provided by U. Geissmann of the Union of Swiss Cities and R. Roth of the Swiss Federal Office of Statistics.

- (b) test propositions about the relative efficiency or inefficiency of governmental production thus stressing the comparative analysis of institutions;
- (c) make some suggestions about the desirable arrangement of the organization of production for a specific municipal service.

The emphasis thus lies in the comparative nature of both the theoretical and empirical approach: no institutional arrangement is perfect, and each institution one can conceivably think of may have an advantage relative to some criterion. If this basic view is accepted it follows that it is necessary to analyze and contrast those institutions which are imperfect. "Market failure" and "governmental failure" coexist.

The specific area studied is the production of private households' refuse collection ^{Abfall Beseitigung} in 103 Swiss cities, of which about half are performed by private collectors

2 (mostly on a contract basis), and the other half by public enterprises which are integrated to different degrees into the civil service. ^{In Schweiz → Abfallbeseitigung}

Part II of this paper reviews the arguments for and against private and public production following from the charac-

teristics of refuse collection, using arguments from the theory of property rights and from the economic theory of bureaucracy. It is shown that there are valid arguments for and against each kind of production arrangement. It is therefore necessary to look at the empirical evidence even if only one specific criterion, production efficiency, is considered. In part III a model of refuse collection for Swiss cities is developed and empirically tested.

The analysis comes to the conclusion that private refuse collection seems to be more efficient than governmental performance in the particular case studied. It is thus incorrect to see public production as the only way to achieve (efficient) public provision of a public service. On the other hand, as is argued in part IV, the solution is certainly not to go over to private production without any further thinking. The government's task does not end once it is decided that production of a service should be private; its activity takes rather a new form. The government has to ^{Sicherung} safeguard that private production continues to be more efficient, in particular it has to find the best way to maintain ^{erhalten} competitive pressure. ^{Wettbewerb durch} This involves problems of information, uncertainty and control.

II. THE RELATIVE EFFICIENCY OF PUBLIC AND PRIVATE REFUSE COLLECTION: THEORETICAL CONSIDERATIONS

1. The Nature of Refuse Collection

Refuse collection has (practically) no properties of a collective good, compared, e.g., with public transport or government run schools. There are, however, negative externalities connected with the consumption side, namely the bad smell and potential ^{2. B.} contagious diseases ^{anstekende Krankheiten} resulting from untreated wastes (Gueron, 1972). In all civilized countries there has therefore been public intervention for a very long time in this area. It is collectively decided that the wastes must be disposed of in regular sequence and treated at specified locations.

To the production side of refuse collection there are not even significant externalities attached (if the noise involved with picking up the garbage is disregarded). ^{Endlagerung} Final disposal of the wastes is again subject to sometimes strong negative external effects in the neighbourhood. This aspect is, however, not further considered in this paper which is concerned only with refuse collection. It is sufficient to indicate that final waste treatment is in Switzerland usually in the hands of the Kantons (states) or of the central government.

The lack of significant externalities of production connected with refuse collection means that a central reason for governmental production does not apply. The production-possibility set has the usual convex properties, and there is no theoretical reason why there should not be private production under competitive conditions²⁾.

2. Characteristics of Public Production

There are two main arguments against public production:

- (a) The fact that instead of private there are public property rights in the production unit means that there is more *Responsibilit* discretion by the managers enabling them to run the firm less efficiently;
- (b) a publicly run production unit is subject to more restrictions than a private firm because it is part of the general public administration. These additional restrictions are very likely to *beeinträchtigt* impair production efficiency.

These two arguments are discussed more deeply: the first relates to the property rights aspect (see, e.g., Alchian, 1967, and the survey by Furubotn and Pejovich, 1972), the second to the bureaucratic organization.

2.1. Inefficiency due to public ownership

Managers of a private enterprise are under competitive conditions forced to follow the interests of the shareholders, ^{d.h.} i.e. to maximize profits and the value of the firm in terms of share prices. If a different, i.e. inefficient, policy is undertaken, the present owners will ^{fläscheln} interfere, or the resulting reduction in the value of shares enables outsiders to gain the majority. In both cases the inefficient management will be ^{entlassen?} dismissed. It is thus in the managers' own interest to choose an optimal output (i.e. ^{den Konsumenten Wünschen entsprechen (Rechnung tragen)} also to take into account consumers' preferences) and to service at the lowest cost possible. The quality and the price of the product are continually controlled by the market.

It is argued that the control of managers' behavior is much ^{Schwächer} weaker in public enterprises. The taxpayer as the "owner" of the firm, and the consumer as the user of the product have little ^{Anreiz} incentive to ^{Gezeiten} exert effective control. There are costs involved for an individual or a group to evaluate how efficiently a firm is run, and there is the "free-rider" problem as the (uncertain) achievement of increased efficiency benefits all the consumers and taxpayers.

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S. 47

With public production, the consumer rarely has the choice to react as in the market, namely to "exit" (for the term see Hirschman, 1970: 21 et seqq.), i.e. to switch to a competitive supplier if the product is unsatisfactory. Often, the only possibility is to boycott the service altogether, or to move to another community, both of which involve sizeable costs.

"Voice" or protest is an alternative (non-market) instrument with which the standard and efficiency of public performance may be ^{verbessert} improved. It is, however, likely to be used and to be effective discontinuously, only, and in the special case of refuse collection it is unlikely to be a focal point around which professional voice-makers (the opposition party) can organize a successful election campaign. This will only happen if there are obvious and large mistakes being made. The management will therefore avoid undertaking actions which might lead to such mistakes, but there is still large ^{spielraum} scope for production inefficiencies.

2.2. Inefficiency due to bureaucratic organization

Even if the management of a municipal firm has the same incentives for keeping costs low (which it has not), it is restricted in so many ways by the specific organiza-

tional principles of government administration that full efficiency cannot be reached. The restrictions are of various sorts: *Restriktion des Managements in öffentl.*

Unter:

(a) Often the goods and services offered by a public firm may not be sold on a market, but must be distributed free, e.g., because the government feels that they are meritorious. The activity is financed by the general budget or by various kinds of taxes not directly related to the quantity consumed. This arrangement may provide a positive incentive, ⁷ if the salary and prestige of the management is in any way linked with the budget size, i.e. with the costs of operation. The dismissal of prices as an allocating device makes it difficult for management to find an output level where marginal costs and benefits balance, to judge when a certain activity should be altogether stopped and to plan an adequate investment policy for output expansion (or contraction).

*S. Zimmermann
S. 50.*

⁷to managerial inefficiency

(b) An even stronger restriction results from the direct intervention of bureaucratic rules and regulations, affecting both the input and output side of a public enterprise.

With respect to inputs, it is reasonable to assume that trade union influence is stronger and - especially in Europe - likely to affect productivity more nega-

tively in public enterprises. The politicians which often depend on the trade union vote for survival will be more ^{gering} inclined to ^{gewähren} grant wage demands and other favours, as the costs of such action (in the form of higher taxes and/or inflation, and - less likely - higher specific prices of public outputs) are distributed broadly over a large section of the population and are therefore relatively little felt. Another reason why politicians are normally ^{widerstrebt} re- ^{legiert} luctant to oppose trade union demands is that a strike in the public sector may strongly reduce their ^{Wiederwahl} reelection chances.

The public managers usually have little say in their sector's ^{Lohn} wage determination. They may not ^{anpassen} adjust relative wages to agree with demand and supply and with the marginal productivity of various occupations and workers. They have little possibility to set wages so as give positive incentives for better work. Quite generally, there are rigid constraints to wage differentiation, because wage increases must be set following bureaucratic rules, in particular age. The restrictions imposed with respect to wages are specially marked in the case of refuse collection where 50 to 80% of costs consist of wages³⁾.

Managers of municipal enterprises are also subject to strong restrictions with respect to hiring and firing. Often workers must be kept on the pay-roll who in the private sector would have been long since dismissed.

It must, however, be stressed that input restrictions of the kind mentioned are not absent in private forms, especially in large enterprises. What matters is that such constraints are much greater in the public sector, and that managers of private firms have more scope for differentiation and discrimination (see Becker, 1971: 31 et seqq.; Arrow, 1973: 10).

There are also bureaucratic restrictions to public managers on the output side. The production level and - what is often more important from the point of view of costs - the distribution between the various kinds of output is often governed by rules and regulations. The management then has no possibility to vary the composition of supply in accordance with changes in costs and (perceived) demand conditions.

With respect to refuse collection there is another reason why managerial efficiency is impaired. Both the quantity and the quality of the output is relatively easy to control, and the bureaucratic interference tend to be accordingly strong, leaving little

room for the managers to ^{Vervolgen} pursue goals of "professional excellence"⁴⁾.[?] Conditions are in this respect quite different from a museum or hospital where managerial effort is concerned with the quality of output (which is, if anything, not worse than in private institutions, but very likely combined with cost inefficiency).

→ To summarize: There are various indications suggesting that public production is inefficient. It may appear to be advisable to switch from public to private production. This conclusion is, however, only ^{gewaant} warranted, if the private organization of production is such as to guarantee the efficiency properties ^{betreffend} pertaining to the model of competitive supply. The point of reference must be the functioning of an institution in the real world, and not a model in which perfect efficiency is guaranteed by the ^{gewaant} appropriate choice of assumptions⁵⁾. The following section is concerned with the possible inefficiencies of private production.

3. Inefficiency in the Private Sector

In the private market economy, inefficiencies may arise from several kinds of lack of competition:

In the case of households' refuse collection there is no competition between a large number of firms⁶⁾: private

collectors receive a licence allowing them to operate in the market, and usually operate under a contract for a fixed period of time. Even if there are several firms in the market, there are few and certainly not the large number of small price takers required for the model of perfect competition to result in efficiency. Competition is at best of an oligopolistic kind making possible a wide variety of results with respect to efficiency .

Market entrance is not free. The case of the existence of high initial investments is, however, of little relevance in the case of households' refuse collection. The difficulty lies rather in the way the production licence may be obtained and in the many rules and regulations which must be observed⁷⁾.

Licences may be acquired by buying an already existing firm in the market (a possibility which rarely exists) or by a decision of the authorities that additional suppliers are needed in order to increase the level and/or quality of performance.

The firms already in the market for refuse collection will of course oppose such an ^{ausdehnung} extension. It may be ^{lohnend} worthwhile for them to form an interest group which seeks to restrict entry, to divide the collection area among existing firms

Vereinheitlichen
and to unify the rates to be asked from the various local authorities. These prices are set so that the more inefficient firms can just survive which means that all the other firms get a differential rent ^(*Gewinn*).

2
2
The rates often have the character of a "cost plus" ^{*Zusatzkosten*} arrangement which constitute an incentive for the firms combined in the interest group to tolerate cost increases as they are compensated anyway. In that case - as in publicly run firms - it may not be expected that private firms resist ^{*wirtschaften ungewerkschaftlich*} unjustified wage demands.

The existence of such regional monopolies to move in this direction is possible and likely to take place due to the strong incentives for the firms already in the field. It should be noted that no solution is provided by suggesting that such a development should not be allowed to happen, thus setting up competition "by decree" ^{*Verordnung*}. The formation of monopolistic markets is the result of a socio-political process behind which there are actors operating in their self-interest which cannot simply be changed by invoking ^{*heraufbeschwören*} the overall superiority of perfect competition. It may well be that the main groups now involved in refuse collection, especially the already operating firms and the public bureaucracy, find such a monopolistic solutions more advantageous ^{*vorteilhaft*} than any increase of competition.

Private contractors and the public bureaus which are supposed to fix the licenses and contracts so as to achieve maximum efficiency, often form a tacit coalition against the rest of bureaucracy and the consumers/ tax-payers, based on their mutual dependence and long acquaintance (see also Stigler, 1971).

^{2.1.1.1} 4. Interim Conclusions

The case for the superior efficiency of private production is no longer so obvious as when public sector inefficiencies are discussed in isolation. There are certainly many ^{to be expected} convincing reasons why public production is likely to be inefficient. It has, however, been shown that as soon as the assumption of perfectly competitive private suppliers is abandoned, inefficiencies must also be expected in the private sector.

Theoretical reasoning alone cannot settle the dispute of whether private or public production is more inefficient. It is thus necessary to resort to empirical tests.

III. THE RELATIVE EFFICIENCY OF PUBLIC AND PRIVATE REFUSE COLLECTION: EMPIRICAL ANALYSIS

1. Previous Studies

The simplest method of determining efficiency differences between private and public production is to calculate the

per-unit costs of refuse collection, the unit being the household, the quantity or weight of waste. A comparison with this measure is, however, most unsatisfactory as the effect of differences in the quality of the service (e.g., where the waste is picked up) and of the technical conditions of production (e.g., whether the topography is hilly) is not allowed for.

A model has been devised which takes account of these differences (Hirsch, 1965). It is assumed that the costs of refuse collection depends on the amount of service (U), the quality of service (Q), the technical conditions of production (T), the level of factor prices (FP) and the level of technological knowledge (TK). The average unit cost per ton (AC) thus is:

$$AC = f (U, Q, T, FP, TK, D_1, D_2). \quad (1)$$

The function also includes two ^{can be taken as the variables} dummy variables (D₁ and D₂) which represent the institutional condition of production (private vs public) and the type of financing (charges to private households vs financing through the general budget).

^{Q. Wickham}
Due to data problems eq. (1) had to be reduced in the application to the household refuse collection in 24 suburbs of the St. Louis City-County area (Hirsch, 1965:

90 et seqq.). The estimation yields:

$$\begin{aligned} X_1 = & 6.16 + 0.000\ 089 X_2 - 0.000\ 000\ 000\ 436 X_2^2 \\ & (0.000\ 195) \quad (0.000\ 000\ 000\ 832) \\ & + 3.61 X_3^* + 3.97 X_4^* - 0.000\ 611 X_5 \\ & (1.14) \quad (1.50) \quad (0.000\ 442) \\ & - 1.87 D_1 + 3.43 D_2^* \quad (2) \\ & (2.40) \quad (1.10) \end{aligned}$$

$$\bar{R}^2 = 0.76; N = 24.$$

The ^{Standardabweichungen} standard deviations are given in ^{klammern} parentheses below the respective parameter estimates, which have an ^{Sperrchen} asterisk if they are statistically significant at the 95% security level. The variables are

X_1 = 1960 average annual residential refuse collection and disposal cost per pickup in dollars;

X_2 = number of pickup units;

X_3 = weekly collection frequency;

X_4 = pickup location, where curb² pickup is 0 and rear of house pickup is 1;

X_5 = pickup density, i.e., number of residential pickups per square mile;

D_1 = nature of contractual arrangement, where municipal collection is 0 and private collection is 1, and

D_2 = type of financing, where general revenue financing is 0 and user charge financing is 1.

It should be noted that the model tests the costs of ^{Abfall-} waste ^{sammeln u. Beseitigung} collection and disposal, and that the costs now refer to

the costs per pickup (and not per household or per ton). The dummy variable D_1 for the type of production institution has no statistically significant influence upon costs; it seems that there is no clear difference of efficiency between private and public production. The type of financing ^{assess.} exerts a significant influence on costs. It is, however, rather surprising that the coefficient is positive. It would be a priori be expected that charges (which are similar to prices) would lead to a higher ^{cost-con} cost-consciousness with the consumers and producers, leading to a pressure to hold costs down.

The question of the relative efficiency of different institutional forms of production of refuse collection has also recently been tested for 27 public and private enterprises in Montana (Pier, Vernon and Wicks, 1974). A production function with fixed proportions of the Leontief-type is found to best fit the data. The cost functions derived lead to the conclusion that public production is less efficient at a low output level, and more efficient than private production at a high output level when capital costs are considered. With respect to labor costs public production is always more efficient than private. For localities larger than about 1750 inhabitants the municipal refuse collection is preferable to the collection by private firms.

The study for Montana is interesting, particularly because it attempts to estimate a production function. It must, however, be criticized on various grounds⁹⁾. Output is not measured by quantities or the number of households served, but rather by pickup places. Differences in the quality and technical conditions of refuse collection are not sufficiently allowed for. Moreover, the methodological approach used is unable to answer the question of the relative efficiency of institutions in a satisfactory way: for private and public production separate production and cost functions are estimated. A comparison of the result with respect to efficiency is ^{zulässig} admissible, only if the two sectors produce under the same general conditions. This can, in general, not be expected. To test the relative efficiency of the two institutional arrangements at various cost levels, one single estimation equation is required for private and public production. The relative effect on average costs can then be isolated by introducing dummy variables for the two types of service institutions.

2. A Model of Refuse Collection for Swiss Cities

A cost function is estimated with the intention of avoiding the ^{unzulänglichkeiten} shortcomings of the previous studies.

Average costs of refuse collection per residential household (AC) are assumed to be influenced by quantitative

and qualitative factors, by the technical conditions of production, by factor prices and the state of technology. The quantity of refuse collected is measured by the number of tons carried away from the households (U_1). In Switzerland it is important to not only consider the refuse created by residential households as there may be a considerable inflow of tourists and foreign workers in the summer and/or winter. An important factor are people who commute between place of residence and place of work.

U_1 is amended by two additional variables: additional seasonal demand U_2 (measured by the number of lodging nights, averaged out on a daily basis and put into relation to the residential population), and U_3 is the additional necessity for refuse collection in a locality due to commuting (commuting in relation to the residential population). It is a priori expected that all three tend to increase average cost.

The quality indicators consist of the pickup location (Q_1), the number of collections per week (Q_2), and the distinction between joint ($Q_3 = 1$) or separated ($Q_3 = 0$) collection of (ordinary) household refuse and ^{Avfallstaly} bulk trash (Q_3).

Average costs are expected to rise, the further away from the street the refuse is picked-up and the more often it is collected (because the quantity per collection is re-

duced). The effect of a joint collection of bulk trash with other household refuse cannot be determined a priori: the handling gets more difficult and there is less possibility for automation but the collectors are already at the pick-up point. Other factors affecting quality are the noise produced (Q_4), and the ^{Unrat} mess left on the street (Q_5), which are, however, difficult to determine quantitatively¹⁰).

Among the technical conditions of refuse collection are the economies of scale connected with increasing density, which is split up into the number of pickup units per square kilometer city region (T_1) and the quantity of household refuse per pickup unit (T_2). Another determinant of importance in Switzerland is the topography (T_3), e.g., measured by the differences in height within a city. The larger these differences, the higher are time and fuel costs. Finally, the size of the distance to the waste deposit site (T_4) may be expected to positively affect average costs.

The factor prices (FP) have an influence on the input mix; the higher the relative cost of labor, the more labor will be substituted by capital.

The state of technological knowledge and its precise influence on average costs, given factor prices, is difficult to evaluate. It may well be that the crew size (TK_1) and the type of equipment used (TK_2) are determined by relative

factor prices and do not have a direct influence on average costs. If, however, there are institutional constraints making it impossible for a refuse collection firm to take advantage of the new technology available, cost may be directly affected (see Downing, 1975: 9 et seq.). The same argument applies, of course, to the firm's adaptation possibility to changes in relative factor prices.

The inclusion of the variables mentioned serves to keep all relevant factors controlled in order to enable the intended comparison between private production ($D_1 = 1$) and public production ($D_1 = 0$). The type of financing is controlled through another dummy variable D_2 ($D_2 = 0$ if general budget financing, $D_2 = 1$ if the households are charged).

The estimation equation thus is

$$AC = h \left(\underbrace{U_1, U_2, U_3}_{\text{quantity}}; \underbrace{Q_1, Q_2, Q_3, Q_4, Q_5}_{\text{quality}}; \underbrace{T_1, T_2, T_3, T_4}_{\text{technical conditions}}; \underbrace{FP}_{\text{factor prices}}; \underbrace{TK_1, TK_2}_{\text{technological knowledge}}; \underbrace{D_1, D_2}_{\text{institutional arrangement and type of financing}} \right) \cdot \quad (3)$$

The theoretically expected signs of the partial derivatives are:

$$\frac{\partial h}{\partial U_1}, \frac{\partial h}{\partial U_2}, \frac{\partial h}{\partial U_3}, \quad \text{all} > 0;$$

$$\frac{\partial h}{\partial Q_1}, \frac{\partial h}{\partial Q_2}, \quad \text{both} > 0;$$

$$\frac{\partial h}{\partial Q_4}, \frac{\partial h}{\partial Q_5}, \quad \text{both} < 0;$$

$$\frac{\partial h}{\partial T_1}, \frac{\partial h}{\partial T_2}, \quad \text{both} < 0;$$

$$\frac{\partial h}{\partial T_3}, \frac{\partial h}{\partial T_4}, \quad \text{both} > 0;$$

$$\frac{\partial h}{\partial D_2} < 0;$$

the other signs cannot be determined through a priori reasoning.

3. The Application of the Model

The basis of the empirical estimation are the data on refuse collection collected by the authors through survey methods. They cover the 112 largest Swiss cities, the smallest being Stans (the capital of the Kanton Nidwalden) with 5100 inhabitants, the largest being Zuerich with 422 600 inhabitants. On the whole more than half the Swiss population lives in these cities.

The data on costs, which includes running costs of production, depreciation and interest on the capital invested, as well as other data relevant to eq. (3), was collected by questionnaire. Additional data was taken from the Statistics of Swiss Cities and from the results of the population census of 1970¹¹). All the data refer to 1970.

Those cities in which industrial and household refuse is collected jointly had to be excluded. For some towns not all of the data necessary were available. For the estimation of the average cost curve there remained 103 cities, of which 55 have a municipal and 48 a private waste collection service.

For some of the variables no satisfactory data could be obtained, in particular for factor prices (FP) and for the state of technological knowledge (TK_1 and TK_2).

The estimation results are given in table 1, equation (4)¹²). A step-wise standard least square multiple regression is used, leaving only those variables in the equation which are either statistically significant at the 95% security level, or nearly so. The variables for the pickup location (Q_1) and for the joint or separate collection of household refuse and ^{Mülltücher} garbage (Q_3) have been excluded due to their insignificant effect on average costs. This

result is quite plausible: in Switzerland refuse is almost always placed near the street so that there are too few observations for the alternative case. The opposing effects of average costs connected with Q_3 just seem to balance.

Table 1 near here

All the variables (with the exception of D_2) have the theoretically expected sign. The most important result is that the dummy variable D_1 indicating the institutional form of production has a negative sign and is statistically significant: public production of refuse collection seems to be subject to higher average cost than private production.

The sign of the dummy variable standing for the type of financing (D_2) is positive which is against theoretical expectations, though it corresponds to Hirsch's estimates given in eq. (2). A careful analysis of the data shows, however, that the two dummy variables D_1 and D_2 are (negatively) correlated. For this reason, the estimation has been repeated, deleting D_2 . The results are shown in table 1, equation (5). The parameter for the institutional production arrangement retains its negative sign, but is

Wiederholen *Streichen d.h. ohne D_2*
behält

Table 1: Estimates for refuse collection costs per household (in sFr), 103 Swiss cities, 1970.

eq.	const.	quantity			quali- ty	technical conditions				insti- tution	finan- cing	test statistics	
		U ₁	U ₂	U ₃	Q ₂	T ₁	T ₂	T ₃	T ₄	D ₁	D ₂	R ²	F
(4)	24.92 (3.52)	50.94** (3.86)	1.119** (2.51)	0.16 (1.64)	9.11* (2.19)	-0.85* (-1.67)	-49.92** (-3.69)	0.03** (2.76)	1.06** (2.72)	-6.59* (1.92)	8.22* (2.24)	0.67	22.27
(5)	21.84 (3.08)	46.75** (3.51)	1.34** (3.01)	0.12 (1.22)	10.88** (2.61)	-0.86 (-1.65)	-45.86** (3.35)	0.03** (2.79)	0.92** (2.39)	-4.15 (1.64)	-	0.66	23.19

The figures in parentheses below the parameter estimates indicate the t-values. An asterisk indicates statistical significance at the 95% level, two asterisks at the 99% level of security.

statistically significant only at a significance level lower than 95%.

In order to test whether there are economies of scale, the cost per ton of refuse collected (instead of per household of the residential population as in table 1) is taken as the ^{abhängige} dependent variable. As the estimates with a log-linear formulation proved to be superior, they are presented in table 2. Equation (6) gives the results including D_1 and D_2 , while in equation (7) D_2 is excluded.

Table 2 near here

With the exception of U_2 , Q_2 and T_2 ↗

(all the coefficients are statistically significant, and all - with the exception of U_1 - have the same sign as in table 1. The negative sign and the size of the coefficient U_1 indicate that there are substantial economies of scale in production: average costs per ton of refuse collected decrease the more refuse is collected. There is also some indication that there are economies of density: an increase in density (T_1 and T_2) seems to decrease average collection costs (but only (T_1) in a statistically significant way).

Tonnen des
von der 4 H.
weggeführt
werden

cf. H. Lollander
Q-Kosten

Table 2: Estimates for refuse collection costs per ton (in sFr), 103 Swiss cities, 1970
(log-linear specification).

eq.	const.	quantity			quali- ty	technical conditions				insti- tution	finan- cing	test statistics	
		U ₁	U ₂	U ₃	Q ₂	T ₁	T ₂	T ₃	T ₄	D ₁	D ₂	R ²	F
(6)	-0.57 (-0.38)	-0.57** (-2.38)	0.004 (0.09)	0.17* (2.21)	0.14 (1.07)	-0.27* (-1.69)	-0.33 (-1.48)	0.41** (2.73)	0.19* (2.23)	-0.23* (-1.94)	0.16 (1.09)	0.59	9.70
(7)	-0.68 (-0.46)	-0.61** (-2.57)	0.02 (0.37)	0.18* (2.26)	0.16 (1.21)	-0.29* (-1.87)	-0.30 (-1.36)	0.45** (3.02)	0.18* (1.69)	-0.18* (-2.17)	--	0.59	10.61

For notes see table 1

It should be noted that in both eq. (6) and (7) the dummy variable for the institutional arrangement of production is statistically significant and of the same sign as in the previous two estimates.

IV. NORMATIVE CONCLUSIONS

From the results of the empirical analysis presented it may seem evident that efficiency requires giving up the public production of refuse collection and to turn it over to private enterprises (at least for the particular cities studied). Such a separation between the demand articulating unit (the governments) and the producer¹³⁾ promises a lower cost production of the same services ^(and) would enable a reduction of individual taxes and/or charges.

As has been argued above, however, private firms are not necessarily competitive. It may well be that in exactly those areas in which - for one reason or other - there is now public production, private firms will form coalitions and will be successful in restricting competition, e.g., by collaborating with the ^{in business} supervising public authorities to prevent new entrants. The existence of strong economies of scale in production suggested by the empirical analysis is another strong factor tending towards the establishment of monopolistic markets (see also Bish and Warren, 1972).

cost on depression

The possible existence of economies of density points in the same direction. In an area with low density (as measured by the number of pickup units per square kilometer city region and the amount of refuse per pickup unit) there are unfavourable technical conditions for each producer, if several of them are producing. It is desirable to split up the area, so that in each area there is only one supplier, but this means that there is no competition - at least for the time period in which a licence is granted by the authorities.

Very clearly, the government's task does not end if it were decided that due to the efficiency advantage refuse collection should be undertaken by private enterprises.

The government only retreats from an area in which it possibly is less efficient than an alternative organizational form, and concentrates upon those areas in which there are no alternative institutions possible. In particular, the government has to set conditions which make private producers function efficiently over the long run.

It has to find ways and means to issue licences and contracts stimulating competition and cost reductions. If the government sets the wrong incentives to private firms, nothing is gained by leading production to the "market".

The contracts offered may, e.g., take the following form (see also Young, 1974):

- They should not cover too long a period (4-6 years) in order to stimulate the competition for the production potential;
- The start and end of the periods covered should be different from one city to another in order to give firms continuous possibilities to enter the competition for contracts;
- For minimizing the risk of bad contracting 'performance bonds' should be required; so the financing institution is responsible (up to the amount of the bond) for carrying collection in the case where bonded contractors fails to stay by the terms of the contract ¹⁴).

In low density areas it is possible to produce pressure to keep costs down by establishing competition for the contracts (as competition on the refuse collection market itself is wasteful). In high density areas there is more scope for open competition in overlapping, if not even in identical markets. One may also think of establishing non-profit enterprises designed to compete with private suppliers. For the reasons discussed above, one should not expect too much from such an arrangement: it may

be that the managers of exactly such non-profit institutions are inclined to highly value a quiet life and to enter into tacit agreements with private suppliers and government bureaucracy. There is no easy way to create competition in markets in which there are factors making *heimliches Einverständnis* collusion worthwhile.

NOTES

1. Exceptions which are concerned with production and cost functions of public services and which take account of the specific problems of output measurement in this connection are, e.g., Ostrom (1973) and Emerson (1975) on police, Ahlbrandt (1973) on fire protection, and several studies on schooling, surveyed by Hirsch (1973: chapter 11).

2. If there are (sizeable) production externalities the aggregate production possibility set may become non-convex, with the result that the competitive price system can no longer be trusted to find the (Pareto-) optimal output level. If, however, the optimal production level is known through some other decision-making mechanism (i.e. if the case discussed occurs), it may still be advantageous to set the relative prices so that competitive firms attain it efficiently. For the whole problem see Baumol and Oates (1975, chapter 8).

3. This figure applies to Switzerland; in the United States it is of similar magnitude, see Ad Hoc Committee on Solid Waste Management (1970).

4. It is in that case also impossible to have inefficiency in the sense of too large an output. See Niskanen (1972: chapter 7).

5. This criticism must be raised against many analyses in the tradition of the theory of property rights where

all too often a perfectly functioning competitive private firm is contrasted with the inefficiencies of public organization. The opposite mistake is committed even more often: It is often said that if there is market failure, the government must take over the corresponding activity (see also McKean and Browning, 1975).

6. The following exposition is more general, but also applicable to Switzerland. Here, the main difference to other countries - such as, e.g., Germany - lies in the coincidence of licencing and contracting. The situation is somewhat different for industrial refuse collection.

7. Especially in Germany, the legislation is so difficult to exactly understand that small firms which cannot afford a lawyer are at times unable to enter a market. This tendency has increased since the introduction of environmental legislation.

8. The analogy to agricultural policy should be obvious.

9. For the general problems connected with the estimation of production and cost functions for American cities see Emerson (1975).

10. A concise study proposing a way to measure noise, esthetics, health, safety and general public satisfaction connected with waste collection is Blair, Hatry and Don Vito (1970), an application is given in Blair and Schwartz (1972: chapter 3 esp.).

11. Schweizerischer Staedteverband, Statistik der Schweizer Staedte, various years; Eidgenoessisches Statistisches Amt (1972).

12. The exact definition of the variables of tables 1 and 2 is:

- U_1 = household refuse (including bulk trash) per residential household (in tons);
- U_2 = inflow of tourists and seasonal workers (average daily number of lodgings for the night in relation to the residential population);
- U_3 = commuters (inflow minus outflow) in relation to the residential population;
- Q_2 = frequency of refuse collection per week: twice per week, $Q_2 = 0$; more than twice per week, $Q_2 = 1$;
- T_1 = number of pickup units per hectar of the city region;
- T_2 = household refuse (including bulk trash) per pickup unit (in tons);
- T_3 = differences of height within the city region (in meters);
- T_4 = distance between the center of the locality and final refuse disposal site (in kilometers);
- D_1 = institutional production conditions: if public production, $D_1 = 0$; if private production, $D_1 = 0$;
- D_2 type of financing: if largely financed by the general budget, $D_2 = 0$; if if largely financed by charges to the households, $D_2 = 1$.

13. For a long time, economists and political scientists have disregarded the possibility and the advantages of such a separation; but see Ostrom, Tiebout and Warren (1961) for an exception.

14. As Young (1974:57) stresses: "While the execution of a performance bond (in the event of a contractor problem) can be a cumbersome matter, the bond is a valuable device, since financial institutions will presumably be unwilling to underwrite irresponsible firms".

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