ANNALES D'ÉCONOMIE ET DE STATISTIQUE. – N° 33 — 1994

A Comparative Performance Study of Postal Services: A Productive Efficiency Approach

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ABSTRACT. – This paper first discusses the notion of economic performance as applied to public enterprises and argues that productive efficiency is an attractive approach to performance measurement for such firms. It then presents an empirical efficiency study of postal services which is aimed at comparing productive performance indicators across countries and at testing the effect of competition and regulation on these indicators.

Performance comparée des postes : une évaluation par l'efficacité technique

RÉSUMÉ. – Cet article d'abord justifie l'évaluation de la performance économique d'un service public du point de vue de l'efficacité technique. Ensuite, il applique cette approche à 16 services postaux observés sur une période de 15 ans. Les indicateurs de performance ainsi dégagés sont partiellement expliqués par le contexte concurrentiel et institutionnel dans lequel ces services opèrent.

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Support from the SPPS (PAC 90/94 141 and SS/D7/005) is gratefully acknowledged. The authors thank Isabelle Companie for her excellent research assistance. They are also grateful to Damien Neven and a referee for helpful suggestions.

1 Introduction

Measuring the performance of a public firm is both a complex and necessary task. It is complex because the objectives of a public firm according to which its performance ought to be assessed are many and often conflicting. It is necessary because a rigorous and objective evaluation of public firms' performance is the most obvious escape from debates which are all too often passionate. It is also needed because such study can be used to grasp the factors contributing to performance, among which one finds the regulatory setting, the organizational status and the market structure. Finally, a good study of performance can be used by public managers and by public authorities as a pragmatic and pedagogical tool towards improvement in moniroting and resources use.

In this paper, we argue in favor of an indicator of performance that measures any firm's capacity to achieve production efficiency, a concept originally due to KOOPMANS [1951] and DEBREU [1951] and close to those of internal efficiency (VICKERS and YARROW [1990]) and X-efficiency (LEIBENSTEIN [1966]).

In the next section, we present the performance approach to public enterprises, focusing on the objectives assigned to the firms and from there on, we discuss the merits of the productive efficiency approach. In the third section, we illustrate this approach by presenting the main findings of a performance study of a typical public enterprise, postal services. As such enterprises operate on a nationwide scale without direct competitors, private or public, the approach is based on a comparison across nations and over time [1]. Our data base being of a cross-section-time-series nature allows for both a static and a dynamic analysis of productive efficiency.

The efficiency indicators so derived can then be used to analyze the links between productive performance on the one hand and competition and regulation on the other hand. The final section presents some conclusions concerning the merits of the productive efficiency approach and its expected contribution to public policy.

2 The Performance Approach [2]

To assess the performance of a firm, more generally of any unit of production, the "principal-agent" relation that links the production manager

1. Postal services are subject to an increasing challenge form private competitors for particular activities such as express and business mail. These activities represent, however, less than 1% of the total outlays of the whole postal sector.
2. This section draws heavily from PESTIEAU and TULKENS [1993].

with the authority ultimately concerned by his/her achievements ought to be first recognized. Performance is then defined by the extent to which the agent fulfills the objective assigned to him/her by the principal. The simplest performance measure in this sense is undoubtedly the profit level of the textbook private firm. Here, as the sole objective of the owners – the principal – is assumed to be the maximization of their revenue, performance in the sense just defined is easily and effectively measured by the profit level achieved by the firm's manager, i.e. the agent.

In the case of public sector activities, if the welfare economics view is followed suggesting the State (taken as representing society as a whole) to be the principal, the objectives appear to be multifold because of the many aspects of social welfare. As a result the objectives assigned to public managers are also multifold, and the performance assessing issue becomes a more complex one.

Following the now well established taxonomy proposed by REES (1984, chapter 2), one distinguishes two classes of objectives: the allocative objectives including productive and price efficiency and the non allocative objectives including equity, financial balance and macroeconomic policy. Multidimensional objectives thus appears to be the rule in assessing performance of public enterprises. Beyond the recognition of this fact, a number of difficulties arise that we now briefly deal with, each in turn.

First, these goals may not always be completely compatible with one another. One knows, for example, that peak-load pricing in services such as transport and communication is desirable from an allocative viewpoint but distributively objectionable. Thus, when assessing the overall performance of such services, a delicate balance has to be struck between these two criteria.

Second, measuring the degree to which those objectives are satisfied is quite a difficult task because it involves computing first an indicator of partial performance for each of them, and then proceeding to some weighting of those indicators. This cannot be resolved without involving basic value judgements.

Third, the only objective the achievement of which does not impede that of the others is *productive* efficiency. Producing too little or employing too many factors as compared to what is technically feasible cannot be justified in terms of any of the other objectives listed above.

Fourth, the trade-offs between allocative and non-allocative objectives can have effects on the controlability of firms. Indeed, a firm can be allocatively inefficient for two reasons, the first being that it has to fulfill non-allocative goals and the second being that the manager pursues objectives of his/her own (e.g., the three P's, power, prestige and pay). The difficulty then arises in sorting out these two sources of inefficiency that has often been presented as an argument in favour of privatization and deregulation. In a competitive setting, a private firm is indeed supposed to be efficient both technically and allocatively.

Given the above, in this paper we choose to measure the performance of public enterprises on the basis of the productive efficiency rule only. In summary, our reasons are twofold. On the one hand, the global performance evaluation problem, i.e. measuring how close a public firm comes to

achieving all the objectives just listed is, in our opinion, too ambitious. On the other hand, as productive efficiency allows for evaluations that are consistent with the manifold objectives of the firms at stake, it does definitely constitute a step in the right direction.

The fact that productive efficiency does not prejudge whether and how other objectives are fulfilled is not its only merit. Another merit is that it can be used not only where public and private activities can be compared but also where public enterprises operate in isolation, with no comparable or competing activity, as is the case of postal services. Indeed, the only prerequisite for measuring productive efficiency is the possibility of constructing a production frontier. Note in this respect that most traditional (i.e. not productive efficiency oriented) empirical studies of performance of public enterprises concern only areas where there are both public and private firms engaged in similar activities. As these are as not very representative of the bulk of public sector, their findings can hardly be generalized.

Another advantage of the productive efficiency viewpoint is that it relies on physical data which is readily available in many instances and basically more reliable that financial or accounting data. Finally, the concept of productive efficiency being both intuitive and unambiguous, its measure usually meets a wide consensus. Admittedly, production efficiency is only a partial indicator of performance. However, compared to traditional indicators such as price, profitability or productivity, it is by far more robust to applications involving firms operating in changing market structures or production settings. Partial productivity can be misleading within a multi-output/multi-input process. Price differentials are quite imperfect indicators of slacks in allocative efficiency. Finally, one knows that efficiency can imply low profitability and in case of decreasing costs, it is compatible with deficit [3].

3 Productive Efficiency in Postal Services

In this section, we present an empirical performance study of postal services that is aimed at illustrating the productive efficiency measurement and at relating the efficiency indicators to features such as competition and deregulation. In other words, we don't limit ownselves to quantifying efficiency but further try to identify some sources of slacks.

Measuring technical efficiency in any firm would be a simple exercise were the frontier production set known. Unfortunately, this is not the case;

3. The idea that technical efficiency can be achieved independently of the other objectives assigned to the firm and particularly of allocative efficiency has been challenged on various counts. On this, see PESTIEAU and TULKENS [1993].

the true production set cannot be merely found in the blueprints of an engineer. It thus must be constructed from a sample of possibly inefficient observations. There are different types of methods which vary from the estimation of a prespecified production function to the construction of a stair shaped envelope of the sample of input-output points. Whatever the method chosen might be, parametric of not, stochastic or deterministic, one should realize that the technical efficiency so measured is of course a relative one [4]. Hence, one often uses the term "best practice" production set, made of those observations that appear to be the best ones in the sense of some posited assumption of dominance.

For that reason, the choice of the sample of observations is crucial. It is important that they originate from similar conditions as to the technology. To take the case of a cross-section-time-series sample of postal services, the question of spatial and intertemporal homogeneity is quite relevant. It is not impossible that geographical and institutional differences across countries go a long way towards explaining variations in performance. Part of the exercise presented below precisely consists in accounting for these differences. Further, over time, differences in technical progress can matter.

In any case, for industries such as postal services which in most countries have a monopoly position, that kind of problem cannot be fully avoided [5]. In the following, we introduce exogenous factors of environment to cope with spatial differences and a trend variable to cope with intertemporal differences.

To construct the production frontier, we use the parametric stochastic method introduced by AIGNER *et al.* [1977] and by MEEUSEN and Van den BROECK [1977] which implies the estimation of a production function. But first, a word about the data.

Physical data are obtained from the UPU [Universal Postal Union (1975-1989)] located in Bern which collects on an annual basis its information from all national members [6]. Our sample is restricted to 16 national postal services and 15 years (1975-1989) for reasons of comparability and availability. As output, we use the number of items mailed plus that of financial operations (y). Three inputs were selected: labor force (x_l), post office (x_k) and equipment (proxied by the number of postal vehicles) (x_q). Average values for those variables are given in Table 1 together with some geographical and institutional characteristics representative of the environment in which these companies operate.

Several remarks can be outlined from this table:

First of all, one can observe that only 16 national companies were retained for this study. These companies, that in all the cases correspond to OECD industrial countries, are assumed to have access to the same technology and,

4. For a survey of the alternative methods proposed for the estimation of production frontiers see SCHMIDT [1986] and LOVELL [1993].
5. National postal services are generally considered as natural monopolies. For a discussion on this issue, see PANZAR [1991] and ROGERSON and TAKIS [1993].
6. In a previous study, PERELMAN and PESTIEAU [1988] used the UPU data with a different set of countries and earlier years.

TABLE 1

Sample Descriptive Statistics (mean values) [1]

Country	Period	Production variables				Environment and institutional characteristics			
		Postal services (y)	Labor (x_l)	Equipment (vehicles) (x_q)	Capital (offices) (x_k)	Mailbox density (d)	Inhabitants per mailbox (h)	Index of tendering (s)	Index of autonomy (a)
		(10^6)	(10^3)	(10^3)		$(1/10^3$ km$^2)$		(%)	
Australia	1975-1988[2]	2 329.8	37.0	6.1	5 004	2.1	907.9	14.8	120
Belgium	1975-1987	896.6	48.6	3.2	1 842	603.9	526.4	0.6	115
Denmark	1975-1989	861.1	28.7	5.4	1 305	257.1	463.1	83.4	110
Finland	1975-1982[2]	387.0	40.9	7.4	3 936	42.6	333.4	0	115
France	1975-1988	10 405.2	274.6	43.5	17 072	284.0	351.5	19.8	95
Germany	1975-1988	6 657.1	275.5	42.2	18 646	442.9	556.6	0	100
Greece	1975-1989[2]	206.8	9.8	1.6	1 294	97.8	748.4	30.1	85
Ireland	1975-1978	204.8	10.5	1.4	2 187	91.6	464.6	35.3	95
Italy	1976-1989	3 815.5	207.1	4.3	14 179	203.7	948.1	0	70
Japan	1975-1988	6 577.3	139.4	67.0	23 091	389.5	814.8	18.4	125
Luxembourg	1975-1989	46.2	1.3	0.2	105	374.2	324.9	2.0	80
Netherlands	1975-1982	1 991.6	54.5	3.5	2 545	388.2	883.4	43.9	100
Norway	1975-1988	413.5	22.4	0.8	2 845	88.2	145.0	12.6	120
Sweden	1975-1983	1 211.2	49.5	3.1	2 365	89.0	206.8	0.3	135
Switzerland	1975-1989	1 165.7	37.0	10.3	3 822	488.6	323.2	4.7	105
United-Kingdom	1975-1987	10 552.9	177.2	29.9	22 267	422.4	545.2	92.9	155

[1] The variables are defined in the Data Appendix. The index of autonomy corresponds to 1984.
[2] Data is missing for some intermediate years and countries: Australia: 1979; Finland: 1977 and 1978, and Greece: 1983.
Source: Universal Postal Union (1975-89)

from this point of view, to constitute an homogeneous panel. Nevertheless, note that due to data availability problems the period covered vary from each country to the other. In the most cases this period correspond to the years 1975 to 1989 but for Finland, Ireland, The Netherlands and Sweden only the first years of the period were available.

Second, we can see on Table 1 that the variables describing the mailing activity show an extremely wide range of operations going from the small Luxembourg's postal service, that employs on average 1 300 workers, to the French and German companies that have near 300 000 employees in their staff. Also we can see that different combinations of production factors coexist within the sample, i.e. the Italian postal company operates with 200 000 workers and 4 300 vehicles compared with the Japanese company that has a staff of near 140 000 employees and 67 000 vehicles.

Third, note that the variables assumed to represent the output and the inputs of the postal activity are in fact obtained by summing up a series of components that in the most cases are not homogeneous. That is for instance the case of the output variable that is defined as the sum of the two main outputs: the total number of letters and financial operations treated over one year. This variable is assumed to be a good approximation of the total output of the postal services even if we know that it is far to be a perfect representation of the complexity and diversification of the whole activity [7]. This simplification, as those introduced for the other variables, were justified by two reasons. On the one hand the difficulty to obtain homogeneous and complete information on the different postal services for each country and period and, on the other hand, the need to obtain a treatable representation of the postal activity that could be resumed by a limited number of variables. As it will be seen later, our objective is to estimate a parametric production frontier on a panel comprising only 16 entreprises over at most 15 years.

Finally, in the last columns of Table 1, are reported the values corresponding to four variables that were selected as the main characteristics describing the environment in which national postal services operate. Within these variables we distinguish two groups [8].

The first one includes: mailbox density (d) and the number of inhabitants per mailbox (h). These variables are assumed to represent the main features of each postal network structure, that is the complexity of the three successive operations in which the postal service is organized: mailing collection, transportation and distribution. Looking at Table 1 we remark that "mailbox density", that must be interpreted as an indicator of the transportation activity, varies a lot across countries when compared with the variable "inhabitants per mailbox" that, on the contrary, must be seen as an indicator of the concentration of the mailing collection and distribution activities.

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7. The reader interested on particular aspects of the postal activities as collection, transportation and distribution of letters, or on specific services as international and express mailing will refer to the two excellent books edited by CREW and KEINDORFER [1991, 1993].

8. For a description of these variables see the Data Appendix.

The second group of characteristics comprises two variables: an index of tendering (r) and an index of regulatory autonomy (a). The first one corresponds to the share of postal offices managed by the private sector and the latter one, derived from a questionnaire sent by the UPU to a number of national postal services, concerns all sorts of regulatory constraints to which these entreprises are subject on different fields of the decision process, i.e. financial policy, marketing and staff management. The values presented in Table 1 show, on the one hand, that only in two countries, Denmark and United Kingdom, the national postal services appeal largely to the private sector and, on the other hand, that it is also the United Kingdom company that appears as the public entreprise that benefit from the highest degree of autonomy when compared, for instance, to the Italian company.

In the following we will assume that these environmental characteristics may affect the performance of postal services as exogeneous factors, that is as factors that are out of the control of the firm's managers even if, specially in the case of the two institutional indicators, this assumption might be seen as rather restrictive.

In order to estimate the productive efficiency of national postal services and the influence of the exogenous variables on efficiency we adopt a two stage procedure following PERELMAN and PESTIEAU [1988] and GATHON and PESTIEAU [1992]. In the first stage we estimate a parametric production function on the basis of the observed output and input vectors using a stochastic approach. From these approach we obtain an indicator of technical performance, specific for each company and year. Then, in the second stage, this indicator is regressed on the four exogenous variables in order to test the influence that those environmental and institutional factors may have on technical efficiency [9].

To construct the production frontier we use the following translog function:

$$(1)\quad \ln y_{it} = \alpha + \beta_l \ln x_{l,\,it} + \beta_q \ln x_{q,\,it} + \beta_k \ln x_{k,\,it} + \beta_{lq} \ln x_{l,\,it} \ln x_{q,\,it} + \beta_{ll} (\ln x_{l,\,it})^2 + \beta_{qq} (\ln x_{q,\,it})^2 + \gamma\, t + \varepsilon_{it},$$

with $\varepsilon_{it} = v_{it} - u_{it}$.

In (1), $i = 1, \ldots, 16$ indicates the postal service and $t = 1975, \ldots, 1989$ the year; v_{it} is a random term with the usual properties $[\mathrm{N}(0,\, \sigma_v)]$ and u_{it} an efficiency term, assumed to be non-negative $(u_{it} \geq 0)$, uncorrelated with v_{it}, and to follow a half-normal probability distribution. This formulation corresponds to a parametric stochastic frontier.

Expected values of technical efficiency for each firm and period are then estimated following the maximum likelihood procedure proposed by

9. Note that this two-stage procedure will be estimated under the assumption of strict separability between the vectors of independent variables involved in the two stages. Otherwise, the coefficients obtained would be inconsistent and unbiased, as shown by DEPRINS and SIMAR [1988].

JONDROW *et al.* [1982] and adapted by BATTESE and COELLI [1988] for the logarithmic production frontier. This is given by:

$$(2) \quad \mathrm{E}\left[\exp\left(-u_{it}\right)|\varepsilon_{it}\right] = \left\{ \frac{1-\Phi\left[\sigma^{*}-\left(\mu_{it}^{*}/\sigma_{*}\right)\right]}{1-\Phi\left(\mu_{it}^{*}/\sigma_{*}\right)} \right\} \exp\left(-\mu_{it}^{*}+\frac{1}{2}\,\sigma_{*}^{2}\right).$$

where: $\mu_{it}^{*} = -\sigma^{2}\,\varepsilon_{it}\,(\sigma_{v}^{2}+\sigma^{2})^{-1}$ and $\sigma_{*}^{2} = \sigma^{2}\sigma_{v}^{2}\,(\sigma_{v}^{2}+\sigma^{2})^{-1}$. Moreover, σ_{u}^{2} indicates the efficiency variance and $\Phi\left[\,.\,\right]$ the cumulated normal probability distribution.

Coming back to equation (1), note that we assume that fixed capital (x_k), that is here represented by the number of postal offices, and the trend variable (t) enter the translog function in a linear way. This specification corresponds to a production technology with constant elasticities of substitution between fixed capital and the two other production factors, labor and vehicles, and neutral technological progress. It is adopted in order to avoid a spurious behavior of the production frontier and doesn't seem to be very restrictive or unrealistic for postal services provision [10].

The estimated translog frontier parameters are presented in Table 2. One sees that they have the expected signs and are significant. The coefficient γ associated with the trend variable indicates an average positive shift of 2.2% of the production frontier each year confirming the existence of substantial technological improvements through the observed period. In particular we think that the trend variable reflects the recent evolution of the mailing processing technology, e.g. the introduction of modern sorting machines. The scale elasticity for mean values of the input variables corresponds to increasing returns to scale (1.086). This result confirms the widespread view that national postal services must be considered as a natural monopoly. Furthermore, we remark on Table 2 that most of the variance of the residual term concerns technical inefficiency $[\sigma_{u}^{2}/(\sigma_{u}^{2}+\sigma_{v}^{2}) = 0.946]$.

In Table 3 we divide the period 1975-1989 in three sub-periods for which average efficiency indicators per country are computed and given. The differences in technical efficiency across countries are quite important. Taking average efficiency over the 15 year-period, it ranges from 0.924 in the Netherlands to a miserable 0.151 for Finland. Finland's low score is partially due to missing data for the later years. The same remark applies to Ireland and its 0.355 score. We next have Greece with an efficiency score of 0.387. The best results are obtained by the Dutch company followed by the Australian and the United-Kingdom postal services.

The rate of technical efficiency change can be obtained from Table 3 by taking the difference between the 1985-1989 scores and the 1975-1979 scores. A number of countries seem to be stable in that respect. Among the exceptions, note efficiency declines in Belgium, Denmark, France, Norway and above all Italy. Note also efficiency gains in Japan, Luxembourg and Switzerland.

10. Each time that this restriction was abandoned the hypothesis of monoticity of the production frontier was violated.

TABLE 2

Postal Services: Frontier Estimation

Dependent Variable: ln y (Aggregated Output)

Independent variables		Coefficients (t-test)		
Constant	1	α	0.428	(5.35)
Labor	$\ln x_l$	β_l	0.541	(9.46)
Vehicles	$\ln x_q$	β_q	0.167	(3.09)
Offices	$\ln x_k$	β_k	0.378	(6.73)
	$(\ln x_l)^2$	β_{ll}	−0.135	(2.69)
	$(\ln x_q)^2$	β_{qq}	−0.203	(6.67)
	$\ln x_l \ln x_q$	β_{lq}	0.338	(4.82)
Trend	t	γ	0.022	
Efficiency variance		σ_u^2	0.356	(5.8)
Share of efficiency variance		$\sigma_u^2/(\sigma_u^2+\sigma_v^2)$	0.946	(20.4)
Scale elasticity (for mean values)			1.086	
Maximum likelihood			−72.9	
CHI^2			16.1	
Number of observations			195	

Note: For a description of the data and variable definitions see Table 1 and the Data Appendix.

TABLE 3

Technical Efficiency in Postal Services

	Average efficiency by period			
Country	1975-1989	1980-1984	1985-1989	All
Australia	0.886	0.906	0.884	0.893
Belgium	0.642	0.588	0.548	0.600
Denmark	0.787	0.709	0.700	0.732
Finland	0.178	0.216	–	0.198
France	0.762	0.725	0.662	0.720
Germany	0.459	0.464	0.444	0.457
Greece	0.392	0.387	0.382	0.387
Ireland	0.355	–	–	0.355
Italy	0.837	0.686	0.665	0.722
Japan	0.728	0.800	0.879	0.797
Luxembourg	0.692	0.783	0.887	0.787
Netherlands	0.934	0.906	–	0.924
Norway	0.680	0.654	0.538	0.630
Sweden	0.724	0.793	–	0.755
Switzerland	0.542	0.571	0.610	0.574
United-Kingdom	0.852	0.841	0.862	0.850

Because of institutional and geographical differences among countries, it would not be fair to blame postal services' management for these observed slacks in efficiency. Hence, we introduce four exogenous factors (autonomy, tendering, mailbox density and population by mailbox) to purge the above

indicators from some sources of inefficiency which are not the direct responsibility of management. In particular, we want to know what the new indicators would be and the ensuing ranking of countries if all postal services were given the same institutional setting, that is, the same degree of autonomy and of tendering out.

One generally expects that ownership, competition and regulation affect production efficiency. As postal services are all State owned, one cannot test in this particular instance whether ownership matters. Postal services also have a monopolistic position and are only subject to competition for some of their operations and through tendering out some of their post offices. For the latter, we have some information and would like to test the widely held view that competition enhance performance. Finally, the indicator of autonomy that was constructed from a survey conducted across postal services can be viewed as reflecting the degree of deregulation that is expected to have a positive effect on productive efficiency [11].

Table 4 presents an OLS estimation of the technical efficiency indicators (te_{ij}) explained by those geographical and institutional factors. The relation tested is the following:

$$te_{ij} = \exp\left[\delta + \pi_a\, a_i + \pi_s\, s_i + \pi_d\, d_{it} + \pi_p p_{it} - \eta_{it}\right], \tag{3}$$

where δ and π's are the coefficients to be estimated and η_{it} the error term $[\mathrm{N}\,(0,\, \sigma_\eta)]$ that is assumed to represent the share of technical efficiency not explained by the exogenous factors.

As expected, Table 4 shows that both autonomy and tendering increase efficiency. The two environmental factors also have a positive effect on efficiency. Then, using the coefficients pertaining to the four explanatory variables, one derives an indicator of efficiency following the approach proposed by GATHON and PESTIEAU [1992] that takes into account the fact that the management *per se* is not responsible of inefficiency due to an adverse environment.

TABLE 4

Determinants of Technical Efficiency

OLS Regression
Dependent Variable: ln *te* (TECHNICAL EFFICIENCY RATE)

Explanatory variables[1]		Coefficients (t-test)		
Constant	1	δ	–1.063	(7.23)
Mailbox density	d	π_d	0.032	(1.37)
Population per mailbox . .	h	π_h	0.031	(3.39)
Autonomy	a	π_a	0.294	(2.44)
Index of tendering	s	π_s	0.182	(2.13)
R^2			0.156	
Number of observations .			195	

[1] For a description of the data and variable definitions see Table 1 and the Data Appendix.

11. See on this PESTIEAU and TULKENS [1993].

Such a measure of management efficiency (me_{it}), free of exogeneous influences, is obtained from the estimated residuals of equation (3) after assuming that the most efficient observation is that corresponding to the maximum estimated value of $\eta\,(\hat{\eta}^{+})$:

$$me_{ij} = \exp\,[-(\hat{\eta}_{it} - \hat{\eta}^{+}]. \tag{4}$$

Furthermore, two complementary efficiency measures can be derived from equation (3). The first one is a measure of regulatory efficiency, re_{it}, that represents the effect that the two institutional variables, "autonomy" (a_i) and "tendering" (s_{it}), have on technical efficiency. This measure is obtained in the following maner:

$$re_{it} = \exp\,[\hat{\pi}_a\,(a_i - a_i^{+}) + \hat{\pi}_s(s_{it} - s_{it}^{+})], \tag{5}$$

where a_i^{+} and s_{it}^{+} are the maximum observable values of these two variables [12]. The second measure, that we identify as an environmental efficiency measure (ve_{it}), is calculated in a similar way on the basis of the observed values of the two respective variables: mailbox density and population by mailbox. That is,

$$ve_{it} = \exp\,[\hat{\pi}_d\,(d_{it} - d_{it}^{+}) + \hat{\pi}_h(h_{it} - h_{it}^{+})], \tag{6}$$

where, as before, the "$^{+}$" superscript indicates the maximum observed values.

In Table 5, the last column gives the indicators of managerial efficiency yielding a ranking different from the one obtained with the indicators of gross efficiency in Table 3. Luxembourg, Sweden and Australia are now leading compared to the Netherlands, Australia and the United Kingdom in the previous ranking. This change can be easily explained. The good ranking of the UK was due to its high degree of regulatory efficiency and that of the Netherlands to its high degree of environmental efficiency. Australia received an average mark for these two indicators. Quite interestingly, the range of indicators is narrower when shifting from gross to managerial efficiency. In other words, exogenous factors act as mitigating circumstances in judging actual performance of management.

Not surprisingly the range of indicators is narrower for regulatory efficiency (0.66 to 1.0) as for environmental efficiency (from 0.61 to 0.84) than for managerial efficiency (from 0.22 to 0.86).

4 Conclusions

In this paper, we have tried to assess the performance of 16 postal services from the viewpoint of technical efficiency. This was done in two steps.

12. Note that the variable "autonomy", that was constructed on the basis of a survey conducted by the UPU in 1984 (UPU, 1984), is assumed to be constant over time for each company.

TABLE 5

Total Efficiency Decomposition [1]

Average values over the 1975-1988 period

Country	Regulatory efficiency (*re*)	Environmental efficiency (*ve*)	Managerial efficiency (*me*)
Australia	0.782	0.745	0.799
Belgium	0.751	0.802	0.518
Denmark	0.860	0.704	0.629
Finland	0.750	0.631	0.217
France	0.733	0.686	0.745
Germany	0.718	0.719	0.431
Greece	0.725	0.731	0.380
Ireland	0.754	0.668	0.367
Italy	0.657	0.804	0.709
Japan	0.799	0.819	0.634
Luxembourg	0.679	0.700	0.862
Netherlands	0.778	0.836	0.740
Norway	0.779	0.605	0.697
Sweden	0.796	0.616	0.801
Switzerland	0.734	0.726	0.561
United-Kingdom	1.000	0.761	0.581

[1] Efficiency levels are calculated with respect to the more favorable situation. That is Italy (1976) and Belgium (1986) for the "mailbox density" and "population per mailbox" factors, respectively, and the United-Kingdom for the "autonomy" and "tendering" variables. Managerial efficiency takes as reference the case of Luxembourg (1987). These values are calculated on the basis of the results presented in Table 3.

First, the level of technical efficiency was derived on the basis of the stochastic parametric approach. It was then corrected to take into account some exogenous factors.

It is clear that such an exercise is only a first but prerequisite stage towards a comprehensive assessment of performance in public enterprises. Even so, there is a lot of room for improvement at this initial stage. In particular, better data on the operations of postal services as well as on the exogenous factors would undoubtedly increase the quality of our findings. Yet, in spite of these limits, we think that the overall picture is correct. The question we are left with is that of the use of such findings.

By no means are we judging the overall performance of the companies concerned. It is not impossible that a company with low productive efficiency could catch up with another more technically efficient company on other grounds of performance. What our results suggest to poorly efficient companies is that they can do better at no expense; we can even point out the particular sources of inefficiency by going back to the production analysis. In other words, and to conclude, a study of technical efficiency such at this, should be viewed as providing a pedagogical tool of betterment for public authorities towards changing the competition and regulatory setting of postal activities and for public managers towards a more efficient use of resources.

Quite often in studies of postal services, the concept of performance is used to reflect the quality of services, in particular the speed of delivery.

It would clearly be interesting to add such quality indicators along with the quantitative indicator of output used here. Through the Consumers' Union, we obtained data on the speed of delivery of various postal items in 11 countries, too few to run a significant test. Note however that we didn't find any significant correlation between that qualitative variable and our alternative indicators of performance.

APPENDIX

Data Appendix

Variables	Description
y . . . . . Aggregated output	Postal services (letters) + financial services (number of operations).
x_l . . . . . Labor	Total number of employees in full-time units.
x_q . . . . . Equipment	Total number of motor-vehicles.
x_k . . . . . Capital	Postal offices in activity.
a . . . . . Index of autonomy	Computed on the basis of the responses given by each company to a UPU survey (UPU, 1984). The questionary covers essentially three fields of the decision process: financial policy, marketing and staff management. For more details, see PALM [1987].
s . . . . . Index of tendering	Ratio of postal offices managed by the private sector.
h . . . . . Population density	Inhabitants per mailbox.
d . . . . . Mailbox density	Average number of mailboxes per 1 000 km^2.

Note: The composition of the sample is given in Table 1.
Source: Universal Postal Union (1975-1989).

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