Estimating the efficiency of marketing expenses: the case of global Telecommunication Operators

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Abstract. This paper investigates the capability of global telecom companies to maximise the efficiency of the productive factors. The shown output is made up of the Total Revenues of the eighteen companies and the inputs consist of the productive factors, which are staff, investments, marketing expenses, traffic of fixed telephony and traffic of mobile telephony. In order to estimate the efficiency of the management of these companies, the Data Envelopment Analysis (DEA) is used. According to the findings of the present research, marketing strategies of telecommunication organizations are characterized by the decline of the traditional marketing expenses and the increased efficiency of investments. The application-driven development of the DEA methodology has led to different approaches being presented in the international literature with different uses and interpretations. The results of this study can be used for efficiency assessments in Decision Making Units.

Keywords: Data Envelopment Analysis, inputs, outputs, productive factors, efficiency

JEL Classification: D6, D49, L5, L96

INTRODUCTION

The economic environment, which naturally affects the former state monopolies, has changed radically since the 1980s, attributed partly to the development of telecoms and the new digital technologies. The value of world Telecommunication services grew by 800% throughout the 1980s and with advances in the transport sector they became the vehicle of multinational enterprises towards globalisation. Deregulation of the telecommunications' sector and the convergence of computers with telecommunications networks led costs downward, coupled with increases in competition and more efficient economies overall.

Within this framework, telecom organisations had to adapt their strategies to the new reality in order to retain their share markets and extend their activities in new areas with the application of fibre optics, cables and satellites. At the same time, the requirement of multinationals, within the globalisation framework, for the creation of transnational fibre optic networks became possible due to the technological advances.

LITERATURE REVIEW

Research into the specifics of 'appropriate' marketing strategies for the telecommunications sector is currently hampered by the lack of existing evidence in the literature combined with the fact that studies to date have tended to focus on the investigation of the overall effectiveness of telecom organisations rather than the outcome of individual marketing policies.

According to D. Gardner et al. (2000), who studied the individual characteristics of marketing strategies for high-tech services, which appear in telecommunications, sales strategies are more important in such sectors. More specifically, they produced questionnaires in order to classify 84 products according to the degree of their technological sophistication. Setting aside parameters like price and distribution channels which affect all products, promotion and sales strategies become more significant when they come to high-tech services.

B. Leisen and C. Vance (2001), after having studied the extent to which the subscribers in Germany and USA were satisfied with telecommunication services they received, concluded that quality factors are the main determinants of consumer satisfaction. However, these factors vary from country to country.

B. Low and W. Johnston (2005) underline the significance of both consumer satisfaction and supplier reliability. These factors determine the acceptance of new and advanced telecommunication services on the consumer side. More specifically, they underline the importance of trust between telecom organisations and their customers as a good solution to the uncertainty facing consumers given the complexity and the high prices of telecommunication services. Wang and Hong (2004) believe that in fully competitive markets, the proper marketing strategy and the constant flow of information back and forth form the basic criteria for the level of the "profit per customer" index.

Based on the above, our study focused on the efficiency of marketing strategies in telecommunication organizations. In addition to the institutional changes that took place in the telecommunications sector, the marketing strategies were also deeply influenced by the technological advances. This is evident in the need for new promotion methods for products and services, not necessarily as costly as the ones used in the past. There is a similar call for increased cost efficiency in marketing expenses. Therefore, organisations need to adjust their strategies by introducing innovative, advanced technologies and services to existing customers rather than simply expand their client base (Curwen 2005).

R. and N. Dholakia (1989) consider multimedia technologies as the next step in telecommunication services and the accompanying marketing strategies for the promotion of such services. As part of their study, questionnaires were sent electronically to different household user categories. According to their results, factors such as "sex" and "former use of mobile phones" were considered statistically significant for the critical mass of consumers and therefore determine the degree of differentiation of a marketing strategy.

M. Agarwal and B. Goodstadt (1997) pointed out in their study on the evolution of mobile communications and its effect on marketing, that intensive competition forced organisations towards the following:

- Creation of a critical mass of customers, by reducing prices;
- Identification and dominance of the appropriate distribution channels;
- Emphasis on a brand name of higher recognition.

METHODOLOGY AND DATA

As pointed out, the former Public Telecommunications Operator (PTO) needed to adapt to a new social and economic environment following the technological and institutional changes that took place within the telecommunications sector.

The main question this present study seeks to address is whether the management teams of the PTO succeeded in maximising the efficiency of the productive factors by taking advantage of the market transformations that appeared as well as by adjusting to the new market conditions. The efficiency of the administration of the former state monopolies during the years 1998-2004 is analysed in order to evaluate the extent to which they 'exploited' the productive factors at their disposal. During this period, all former state monopolies had been fully or partially privatised and the procedure for the modernisation of their networks was in most cases being completed.

In order to estimate the performance of the management of the former national incumbent, Data Envelopment Analysis (DEA) was used. The DEA methodology shows the relative efficiency of each operator, based on its inputs and outputs (Sherman 1984, Banker et al. 1986, Morey et al. 1990, Thanassoulis et al. 1995, Maniadakis and Thanassoulis 2000). In our study, the estimation took place during four distinct time periods: 1998, 2001, 2004 and 2006.

Several researchers have attempted to examine the evolutions that took place within the telecommunications sector using varied quantitative methods [Greenstein & Spiller (1995), Edirisurija (1995), Karunaratne (1995), Maddock (1995), Welfens (1995), Zhao & Junjia (1994)]. Chang et al. (2003) approached the US and E.U. telecommunications markets from an investment behaviour and institutional change perspective. Aniruddha and Ros (2004) approached the comparative development of both fixed and mobile telephony in 61 countries, member states of the OECD, using Cluster Analysis.

Madden and Savage (2000) used econometric analysis to study the manner in which telecommunications and economic development are correlated on an international basis. In addition, D'Souza et al. (2002) studied the efficiency of former state monopolies just before and after their privatization from 1981 until 1998 using panel data estimation techniques. Other researchers have also carried out relevant studies using the same method [Ros (1999), Wallsten et al. (2000), Noll (2000)]. They all concluded that following privatization, profits, efficiency and investments showed an increase. Nevertheless, this is not attributed solely to

the privatization itself but also to the institutional changes that took place in the same time period.

Giokas and Pentzaropoulos (2000 & 2002) have analyzed the efficiency of the main telecommunication providers in the E.U. and the "local offices" of the HTO, using the DEA method. Several researchers opt for the DEA method in order to evaluate the efficiency of telecommunication markets [Debreu (1951), Koopmans (1951), Farrell (1957), Charnes et al. (1978), Seiford & Thrall (1990), Leibenstein & Maital (1992), Greene (1993), Coelli & Perelman (1999), Coelli & Perelman (2000)]. The same method has also been used by Papadimitriou (2006) in order to analyze the efficiency of eighteen telecommunication companies for the period 1998-2004. Finally, Tsai, Chen, and Tzeng (2006), and Shiu-Wan Hung; Wen-Min Lu (2007), studied the productivity efficiency of Forbes ranked leading global telecom operators by combining multiple inputs and outputs.

Basic methodology of DEA

Data Envelopment Analysis (DEA) is indeed a very popular non-parametric method based on linear programming for assessing the relative efficiency of a homogeneous group of decision-making units in the presence of multiple outputs and multiple inputs.

The most frequently used models are the CCR model and the BCC model. The CCR model, proposed by Charnes et al. (1978), assumes a constant-returns-to-scale relationship between inputs and outputs. On the other hand, the BCC model introduced by Banker et al. (1984) is formulated under a variable returns to scale assumption. Each of these models can be measured in two ways: in an input orientation or in an output orientation. An input oriented model aims to minimize inputs while producing at least the given output levels. In contrast, the output oriented model maximizes the outputs for a given level of inputs (Cooper et al. 2007).

The CCR model

In this study the output-oriented CCR model was applied to measure the relative efficiency of the former state telecommunication incumbents. Such a model (Charnes et al. 1978) could be expressed as follows:

$$\left(\max\right) \; \phi_k = \phi_k - \varepsilon\left(\sum_{i=1}^{m} s_i^{-} + \sum_{r=1}^{s} s_r^{+}\right) \quad (1)$$

st.

$$\sum_{j=1}^{n} \lambda_j x_{ij} + s_i^{-} = x_{ik} \; , \; i=1,....,m \quad\quad (2)$$

$$\phi_k - \sum_{j=1}^{n} \lambda_j y_{ij} + s_r^{+} = 0 \; , \; r=1,....,s \quad\quad (3)$$

$$\lambda_j \geq 0, \; s_r^{+} \geq 0, \; s_i^{-} \geq 0, \quad\quad\quad (4)$$

Where m is the number of inputs, s the number of outputs, φ_k is the efficiency index (the intensity factor) of observed DMU_k, x_{ij} the amount of the i-th input of DMU_j, y_{rj} the amount of the r-th output of DMU_j, l_j the dual weight for DMU_j, s_r^{+}, s_i^{-} are respectively, the slacks in normalized output and input variable r and i.

Unit DMU_k is CCR efficient if the optimal value equals one $\varphi_k^{*}=1$. For all inefficient units the value of the function is bigger than one (Martic and Savic 2007).

In order to measure the efficiency of every operator, such output oriented CCR model was solved iteratively 18 times, as the number of our DMUs. The estimated efficiency scores are shown in Table 2.

Data Collection

The study sample included of 18 leading telecom operators. The majority (15) operates in the European telecommunications market and the rest represent the telecommunication markets of Asia, Africa and South America (NTT, Telcom, Telefonica Chile respectively).

Data on the inputs and output variables were collected directly from the telecom companies' annual reports from their company websites. Descriptive output and input statistics for the sample data are provided in Table 1.

The output variable used in this study is the Total Revenues of the eighteen operators of the sample and the input variables consist of the following productive factors:

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- Staff
- Investments
- Marketing expenses
- Traffic of fixed telephony
- Traffic of mobile telephony

TABLE 1: Main Descriptive statistics on input and output variables

Variables	Mean	Std. Dev.	Minimum	Maximum	Median
Year: 1998					
Revenues	13.008	17.602	1.422	72.187	4.768
Staff	63.549	68.384	8.985	226.000	23.260
Investments	3.213	5.057	542	22.626	970
Marketing Exp.	951	1.497	24	6.505	375
Fixed Tel. Traffic	53.662	57.486	8.055	194.400	25.023
Mobile Tel. Traffic	4.609	6.538	330	26.880	1.873
Year: 2001					
Revenues	19.045	22.274	1.925	81.389	7.087
Staff	69.147	79.429	7.720	241.660	22.348
Investments	4.376	5.223	291	20.021	1.884
Marketing Exp.	1.646	3.136	55	13.850	499
Fixed Tel. Traffic	63.185	68.296	10.254	205.100	27.103
Mobile Tel. Traffic	11.678	18.401	1.067	81.648	4.723

Year: 2004					
Revenues	21.359	25.157	1.788	92.965	9.435
Staff	67.642	83.140	4.299	247.559	25.106
Investments	3.483	4.593	203	15.525	1.339
Marketing Exp.	1.377	2.849	42	12.883	579
Fixed Tel. Traffic	54.822	66.228	7.802	216.800	23.000
Mobile Tel. Traffic	15.380	22.546	2.000	97.000	6.145
Year: 2006					
Revenues	24.254	27.302	1.388	89.995	10.122
Staff	67.541	82.772	3.660	248.480	28.448
Investments	4.650	5.985	227	19.851	1.625
Marketing Exp.	1.763	3.929	56	17.708	649
Fixed Tel. Traffic	49.057	59.303	6.982	200.000	18.250
Mobile Tel. Traffic	16.602	21.268	2.100	90.210	7.231

Values of Revenues, Investments and Marketing expenses expressed in US$ million deflated to 1998. Traffic of fixed telephony and Traffic of mobile telephony expressed in million minutes.

EMPIRICAL RESULTS

Rating Efficiency

Based on the median and medial value of the sample, an improvement over time can be seen as far as the sample's total productive efficiency rate is concerned. That is, according to the results, the operators' management teams appeared to have confronted the challenges and took advantage of the opportunities that were presented.

As shown in the following Table 2 and Graph 1, the mean value of the final productive efficiency rate of the organizations was 80.36% for the year 1998 and climbed to 90.48% for the year 2006. Thus, it can be argued that this is indicative of the positive evolution among the used variables, while the median value shows higher increase with values reaching80.36% for 1998 and 97.31% for 2006. A modern business orientation, linked mainly to new marketing strategies and a drop in operational expenses, appears to have resulted in an overall improvement in corporate efficiency.

From the data that emerged from the application of the DEA CCR output-oriented model for 1998, 2001, 2004, 2006, and presented in Table 2, it is observed that 3 operators appear to be constantly efficient and to utilize the available productive factors to an excellent degree. The Japanese NNT, the Swiss Swisscom and the German group Deutsche Telekom are the operators that rank first among the sample throughout the years in question. Furthermore, Table 3 presents the frequency with which these companies are used as 'benchmarks' for comparison with those companies deemed inefficient. Table 3 indicates that Swisscom ranks first in this respect by far, being used as a benchmark for a total of 11 'inefficient' companies. NNT and Deutsche Telekom follow with 4 and 3 companies respectively. On the other hand, Telefonica Chile ranks amongst the lowest in the comparative assessment and exhibits a continuously downward path. Cesky Telecom ranked in the middle of the list in 1998, but managed to climb to the top spots in 2004 and 2006. In fact, for 2004 the company is included among the group of optimally operating firms. This stellar ascent in performance of the Czech operator is most likely attributed to the privatization process that was completed in that period and resulted in the acquisition of Cesky Telecom by the Spanish Telefonica.

TABLE 2
Relative Efficiency Score

OPERATOR	1998	2001	2004	2006
NTT	100,00%	100,00%	100,00%	100,00%
Cesky Telecom	50,79%	55,39%	100,00%	94,62%
Matav	60,84%	76,72%	74,66%	91,37%
Telkom	53,38%	76,86%	97,28%	88,75%
Telefonica	91,17%	81,79%	96,53%	100,00%
Swisscom	100,00%	100,00%	100,00%	100,00%
TDC	94,02%	98,69%	72,74%	81,47%
Telekom Austria	100,00%	100,00%	82,75%	71,84%
Portugal Telekom	89,35%	85,03%	84,39%	82,39%
Telenor	67,71%	70,20%	100,00%	100,00%
Deutsche Telekom	100,00%	100,00%	100,00%	100,00%
France Telecom	66,68%	81,80%	65,66%	67,67%
Telefonica Chile	64,19%	67,14%	72,37%	63,72%
Telekom Italia	68,64%	100,00%	90,79%	100,00%
KPN	78,99%	65,28%	89,69%	100,00%
OTE	100,00%	98,09%	75,04%	100,00%
Belgacom	79,78%	67,24%	87,04%	86,76%
Telia Sonera	80,94%	77,01%	93,29%	100,00%

GRAPH 1
Median and Middle Price of the Final Efficiency Score for all 18 Operators
of the Sample
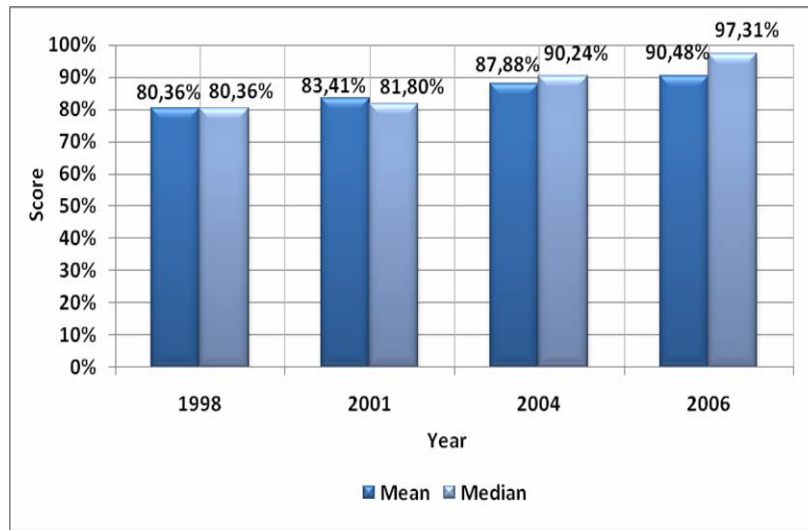
TABLE 3
Frequency in Reference Set

REFERENCE	1998	2001	2004	2006
	Frequency to other Operators			
NTT	6	5	3	1
Swisscom	13	10	13	9
Deutsche Telekom	4	5	4	0

Contribution of each Productive Factor to the Final Efficiency Score

Each productive factor contributes with a different annual percentage rate towards the final efficiency score. The following conclusions emerged based on the results concerning the productive factors that contributed with more than 40% towards the final score for each company (Table 4):

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- Marketing expenses show an increased frequency during 2001, when the telecommunications market was confronted with several challenges such as the financial downturn, the increased competition, the limited return on investments and the reduced net profits among others. As a result these organizations pursued their strategic objectives using new marketing strategies. However, the contribution of "Marketing Expenses" to the final score in the year 2006 is limited, due to the reduction of advertising expenses.

- Investments became a key factor, contributing to the final score. This observation underlines the fact that operators adopted a more balanced investment policy through reductions, by focusing on the development of innovative products and services and by pursuing operations in markets outside their base.

- The factor "Staff" has a limited action within the specified time period, which is expected given that most operators were keen to lower employee numbers in total.

- The results regarding fixed telephony were limited as well. This area of activity affected the final score only during 1998, when networks became digitalized and the previously unmet demand was satisfied.

- The input "Traffic of mobile telephony" shows the contribution of mobile telephony to the productive efficiency rate of the former state monopolies. This contribution rate is, therefore, predictable, especially during the first years of operations. The limited contribution of this input during 2004 is attributed to the intensive competition in this market, but also to the saturation of the developed markets. On the other hand, the technological evolution in mobile communications requires the readjustment of strategies and the promotion of new products and services such as 3G-based technologies.

TABLE 4

Frequency of Productive Factors with a more than 40% Contribution Rate to the Final Efficiency Score

INPUTS	1998	2001	2004	2006
Staff	5	1	3	6
Investments	4	2	9	7
Marketing Expenses	2	6	3	2
Traffic of Fixed Tel.	7	4	2	2
Traffic of Mobile Tel.	5	6	2	2

The DEA defines the inefficient productive factors and therefore gives the operators the opportunity to spot the areas of negative efficiency. Table 5 illustrates the inefficient productive factors with the highest frequency; these are "Staff" and the "Marketing Expenses" variables. This was expected to a certain degree given that operators were pursuing policies aimed at employee number reductions and lowering of operational expenses.

TABLE 5

Frequency of Inefficient Productive Factors

INPUTS	1998	2001	2004	2006
Staff	10	10	7	5
Investments	5	8	5	3
Marketing Expenses	10	8	10	4
Traffic of Fixed Tel.	5	8	7	1
Traffic of Mobile Tel.	8	6	7	7

TABLE 6

Required Changes of Input Variables for the Year 2006

Inputs	Target (Mean Values)	Required Change
(I) Staff	34.009	-14,85%
(I) Investments	2.593.908.732	-10,13%
(I) Marketing Expenses	735.611.968	-30,72%
(I) Traffic of Fixed Telephony.	22.142.860.310	-3,43%
(I) Traffic of Mobile Telephony	8.319.398.512	-29,67%

According to Table 6, inefficient operators have to reduce their inputs and especially their marketing expenses in order to become fully efficient. The required reduction of fixed telephony traffic is due to the reduction of the prices and to the limited use of fixed telephony by consumers.

CONCLUSIONS

In summary, it should be noted that the mean price of the final productive efficiency rate of the organizations is showing an increasing trend over the years, that is 80.36% for the year 1998, 83.41% for the year 2001, 87.88% for the year 2004 and 90.48% for the year 2006. As far as the five inputs used in the DEA method are concerned, the following were observed:

- The marketing expenses show a declining tendency over the years in regard to their contribution towards the final score. At the same time, as an input, marketing expenses have to be reduced extensively in order to achieve a perfect exploitation of all available inputs. The reduced traditional marketing expenses (advertising) are still ineffective. This fact is indicative of the need to further cut down costs and review the chosen marketing strategies.
- Investments are the determining factor for the final score for the years 2004 and 2006, a fact that can be attributed to the improved exploitation during recent years. The high utilization degree of this input indicates the success of products and services that most operators offer.

- The factor "Staff" appears to contribute very little to the final score. Even though it is declining in absolute numbers, it is shown as an ineffective productive factor. Further reduction of employees is required in order to increase the total efficiency of the sample.
- Finally, there is a need for improved utilisation of the fixed telephony networks in terms of the use per customer (traffic), while the exploitation of mobile telephony networks is satisfying. Exploitation of the networks requires proper marketing strategies in order to achieve more intensive use of services by customers of the former state monopolies.

Summing up, the analysis has shown that the marketing strategies undertaken by telecommunication operators are described by the lucid reduction of the traditional marketing expenses, the increased efficiency of investments (new services and products) and on the other hand by the need for reduced employee numbers and better exploitation of fixed and mobile telephony infrastructure. These elements are directly related to the marketing principles of the sample's operators. Despite the changes brought about during the period 1998-2006, there is still a need for radical technological and institutional changes in order to improve the operators' adaptive capacity within the telecommunications markets.

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