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ON THE EVALUATION OF BRAZILIAN LANDLINE TELEPHONE SERVICES COMPANIES

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Abstract

In this work we investigate the relative efficiency of 34 Brazilian Landline Telephone Service companies using Data Envelopment Analysis with weight constraints in the input and output variables. We formulate two different models that take into account the performance of the companies with respect to the criteria defined by Brazilian National Agency of Telecommunications (ANATEL). We also illustrate the potential of efficiency improvement through the simulation of corporate Merger.

Keywords: DEA, telecommunications, weight constraints.

Resumo

Neste trabalho investigamos a eficiência relativa das 34 operadoras do Setor de Telefonia Fixa Comutada através da utilização de Análise de Envoltória de Dados com restrições nos pesos das variáveis de input e output. Formulamos dois modelos distintos que levam em consideração o desempenho das empresas quanto aos critérios definidos pela Agência Nacional de Telecomunicações (ANATEL). Também ilustramos o potencial de melhoria de eficiência através de simulações de fusões corporativas (Merger).

Palavras-chave: DEA, telecomunicações, restrições nos pesos.

1. Introduction

The privatization of the Landline Telephone Services in Brazil and the opening of the market for international operators caused significant changes in the profile of the companies offering these services, since they are now operating in a highly competitive environment as opposed to what happened in the past.

The Brazilian National Agency of Telecommunications (ANATEL) maintains an intense control of those companies, rewarding good results – for instance, through the permission of access to competition in new operation areas – and punishing through fines the non-accomplishment of the established goals.

In July of 1998 ANATEL settled goals to be measured on the last day of the up coming 5 years. Goals were settled for each company with regard to the Quality of the services provided (see "Plano Geral de Metas de Qualidade para o STFC", 1998) and the so called "Universality" issue – which says respect to all citizens right to wide access to telecommunications services (see "Plano Geral de Metas de Universalização para o STFC", 1998).

This work fits in the context of ANATEL's continuous effort in evaluating the performance of 34 companies that are regular operators in the Brazilian Landline Telephone Service (called STFC – Serviços de Telefonia Fixa Comutada – operators). With a similar purpose Milioni developed for ANATEL (Milioni, 2001-a) an AHP model (Analytical Hierarchical Process) that took in consideration specific aspects of Universality, Quality and Fees associates to each company. Milioni concluded that for the comparison of the companies the Fee aspect was practically irrelevant, since all companies practice the maximum allowed fee except for very specific schedules of the day or punctual promotions and loyalty contracts. Although interesting, the results of Milioni, as a consequence of the technique used in his work, are limited to the ranking of the analyzed companies.

The methodology we use in this work is Data Envelopment Analysis (DEA), a non-parametric method developed to evaluate the relative efficiency of different entities of a common nature. Based on linear programming techniques, DEA is considered a robust tool for the evaluation of relative efficiencies as well as for the establishment of goals (or benchmarks) for the entities out of the efficiency border (or envelope). The analyzed entities or DMU's (for Decision Making Units) are compared under Farrel's concept of efficiency (Farrel *et al.*, 1962), that consists of a ratio of the weighted sum of the outputs y over the weighted sum of the inputs x of each DMU. The decision variables are u, the vector of weights of the outputs y, and v, the vector of weights of the inputs x. The choice of intervals that restrict the weights u and v is a subject of current research and it constitutes object of interest of this work.

The first DEA formulation (Charnes *et al.*, 1978), which became well known as CCR Model, supposes constant returns to scale (CRS). The also well known BCC Model (Banker *et al.*, 1984) supposes variable return to scale (VRS). One of the purposes of a DEA formulation is establishing projections of inefficient DMU's on the efficiency border, settling down goals that turn them efficient. One way of doing that, in the so-called input-oriented models, is through the decrease of the input, keeping the output constant. Similarly, in the output-oriented models, we increase the output holding the input constant (Cooper *et al.*, 2000).

For the purpose of comparing the efficiencies of the 34 Landline Telephone Services companies we developed two models. In the first one the inputs represent the main cost components and the outputs represent the products that generate revenue for the companies.

Our second model deals with the evaluation of the services provided (Quality and Universality) taking into consideration the situation in two distinct instants of time: July of 1998, when the Quality and Universality goals were settled, and December 31st of 2000, the most recent instant for which there were data allowing the comparison of actual figures with settled goals.

In Section 2 we describe each model and in Section 3 we address the issue of imposing constraints on the values of the decision variables. In Section 4 we present our results and in Section 5 we develop a simulation on the consequences of two possible merges. Finally, we close with Section 6 where we present our final remarks.

2. The Models

2.1 Model 1

In this model the inputs represent the main cost components and the outputs represent the products that generate revenue for the companies. The variables we use are the following:

Inputs:

- **L** – Labor (or, number of regular employees + subcontracts): represents the largest cost component.
- **PT –** Number of Public Telephones Installed: relates to the investment on both, the installation and the maintenance of public phones.
- **AI** – Number of Fixed Accesses Installed: same as above for non-public phones.

Outputs:

- **MN** – Number of charged minutes in national connections: according to ANATEL, it is the first revenue indicator.
- **P** – Number of local pulse: second revenue indicator.
- **AS** – Number of Fixed Accesses in Service: it produces a monthly account subscription fee plus installation costs covered by the user.

The data were supplied by ANATEL and refers to the situation observed on December 31st, 2000 (see Table 1A, Appendix).

Since the discretionary variable is Labor, we will use an input-oriented formulation. We use a BCC and a CCR model in order to compute both, the technical and global efficiencies, respectively. We also compute the CCR and BCC efficiencies ratio, or scale efficiency. Then, we analyze the companies in terms of their relative size for the business and their competence in managing internal resources.

2.2 Model 2

The objective of Model 2 is to put in perspective the results obtained by each DMU with respect to Quality and Universality goals under the light of the amount invested and revenue level achieved by the DMU.

Inputs:

$$X1 = (4MN + P)/L \tag{1}$$

In the numerator of the ratio we have a revenue indicator (the average revenue per minute in national connection is four times the same for local connections) and in the denominator we have a cost indicator. Companies with greater X1 values achieve higher profit levels and thus they have greater potential of investing in Quality and Universality.

$$X2 = AS/AI \tag{2}$$

Revenue is proportional to the number of fixed accesses in service (AS), whereas cost is proportional to the number of fixed accesses installed (AI). Thus, the X2 ratio is an indicator of the quality of the investments of each company.

Outputs:

As we have seen, AI and PT (number of public telephones installed) data refer to December 31^{st} of the year 2000. Now, let AI_{98} be the same as AI and let PT_{98} be the same as PT but now both measured in July of 1998, when Quality and Universality goals were settled by ANATEL. Let us also consider, as in Milioni's AHP formulation (Milioni, 2001-a), that the improvement on the number of fixed accesses and public telephones are equally important for ANATEL. Then, our first output, defined as an indicator of Universality, will be:

$$Y1 = [(AI - AI_{98})/AI_{98}] + [(PT - PT_{98})/PT_{98}] \tag{3}$$

i.e., Y1 is the sum of the relative increase on the number of fixed accesses and public telephones installed in December of 2000 with respect to July of 1998, when the goals were settled by ANATEL. Data on AI_{98} and PT_{98} can be found on Table 3A in the Appendix.

Output 2 is a measure of Quality improvement. Five indicators were chosen to compose output 2: Number of Repair Request per 100 accesses (RR); Number of Repair Request per 100 Public Telephones (RP); Invoice account error per 1000 invoices (IE); Relative Frequency of Local Completed Calls (LC) and Level of Digitalization (DL). For the establishment of each one of them, the following procedure was adopted: We first compute the difference among the value of the indicator for each DMU in December of 2000 and in July of 1998. Then we compute the average of all those values. Next we compute the reason between the value obtained for each DMU and the overall average. The final result is a weighted sum of the five ratios computed as above. We considered the same relative weights as in Milioni's AHP formulation (Milioni, 2001-a), i.e.: 10% for RR, 20% for RP, 20% for IE, 20% for LC and 30% for DL. Thus, Output 2 becomes:

$$Y2 = 0.1\frac{RR_o}{RR_m} + 0.2\frac{RP_o}{RP_m} + 0.2\frac{IE_o}{IE_m} + 0.2\frac{LC_o}{LC_m} + 0.3\frac{DL_o}{DL_m} \tag{4}$$

Subscript *zero* represents the result associated to the DMU under analysis and subscript *m* represents the average value of referred indicator for all DMU's.

We choose an output-oriented BCC model since we have normalized data and we want to analyze the companies for the results and possibilities of improvements related to Quality and Universality criteria and not for the resources they use to reach their results.

3. Restrictions on virtual inputs and outputs

The concept of virtual input (output), defined as the product of the value of the input (output) and its respective weight was created in order to make possible the verification of the relative share of each input or output in the objective function.

Specialists arbitrarily establish the range of share of each input (output) in the objective function by choosing the constants φ_r e ψ_r (Allen *et al.*, 1997) such that:

$$\varphi_r \le \frac{u_r y_{rj}}{\sum_{r=1}^{s} u_r y_{rj}} \le \psi_r \tag{5}$$

A variation of equation (5) is used when we want to establish an approximate interval for all DMU's through the mean value of the inputs (outputs). This way, we define general tendencies of relative share of the variable in the objective function.

$$\varphi_r \le \frac{u_r \sum_{j=1}^{N} y_{rj}/N}{\sum_{r=1}^{s} u_r (\sum_{j=1}^{N} y_{rj}/N)} \le \psi_r \tag{6}$$

In the case of three outputs we can rewrite above equation, for instance, in the following way:

$$\varphi_1 \le u_1\, MO1/(u_1\, MO1 + u_2\, MO2 + u_3\, MO3) \le \psi_1 \tag{7}$$

where MOq is the average of output q, q=1,2,3.

In order to run Models 1 and 2 we used the pattern of dividing each output (input) by its respective mean value (Allen *et al.*, 1997). Therefore, the value of MOq will be equal to 1 for all q. Let thus be the notation *u*' for the weight of the output divided by its mean value and *v*' the same for the input.

3.1 Model 1

Among the three inputs of Model 1, the one known to be the most relevant for the company is Labor (L). Thus, we adopted that such variable has a tendency of share in the objective function varying from 50% to 75%, including the following restriction in the virtual input:

$$0.50 \le v_1'/(v_1' + v_2' + v_3') \le 0.75 \tag{8}$$

where the indexes 1, 2 and 3 are with respect to L, PT and AI, respectively.

Treating $v_2' + v_3'$ as just one variable represented by $(v_2' + v_3')$ we arrived, starting from inverting the equation presented in (8) followed by a simple algebraic treatment, to the following equations, that are the constraints to be included in the model:

$$v_1' - (v_2' + v_3') \ge 0 \qquad \text{and} \qquad -v_1' + 3.(v_2' + v_3') \ge 0 \tag{9}$$

Above constraints act in the value of the weight of the variable L in relation to the sum of the referring weights of AI and PT.

Now, considering that, in general, the maintenance and operation costs of a public telephone are larger than the ones of a fixed access, we arbitrate that the relationship of the share of those two variables is of 3 to 1, i.e.:

$$v_2' \geq 3.v_3' \tag{10}$$

We acted in a totally similar way in the case of the outputs, considering that the main output of a company says respect to the Number of charged minutes in national connections (MN). Thus:

$$0.50 \leq \frac{u_1'}{u_1'+u_2'+u_3'} \leq 0.75 \qquad -u_1'+3(u_2'+u_3') \geq 0 \quad \text{and} \quad u_1'-(u_2'+u_3') \geq 0 \tag{11}$$

where the indexes 1, 2 and 3 are defined with, to MN, P and AS, respectively.

We also defined, in relation to the outputs P and AS, that the relative share of the first should be 3 times greater than the one of the second. Thus,

$$u_2' \geq 3.u_3' \tag{12}$$

3.2 Model 2

In Model 2 we have two input and two output variables. Considering X1, as the most relevant variable in Model 2, we adopted as before (Model 1) that it has a tendency of share in the objective function varying from 50% to 75%. Thus, we have:

$$0.50 \leq u_1'/(u_1'+u_2') \leq 0.75 \tag{13}$$

where the indexes 1 and 2 are with respect to X1 and X2, respectively. From (13), we get, as before:

$$2 \leq \frac{u_2'}{u_1'}+1 \leq 4 \Rightarrow 1 \leq \frac{u_2'}{u_1'} \leq 3 \quad \Rightarrow \quad -u_1'+u_2' \geq 0 \quad \text{and} \quad 3u_1'-u_2' \geq 0 \tag{14}$$

Considering both outputs as equally important, we defined a constraint rule designed not to allow that the DEA solution has either very low or very high values for each of them. In that sense, we impose:

$$0.30 \leq v_1'/(v_1'+v_2') \leq 0.70 \tag{15}$$

where the indexes 1 and 2 are with respect to Y1 and Y2, respectively. From (15), we get:

$$-0.43v_1'+v_2' \geq 0 \quad \text{and} \quad 2.33v_1'-v_2' \geq 0 \tag{16}$$

4. Results

Using the software EMS (Efficiency Measurement System, version 1.3 – Aug., 2000) to run the two proposed models, we obtained the results presented in Table 1 ordered by the efficiency measured according to Model 2.

Table 1 – Efficiency results according to Models 1 and 2 (all in %)

		Model 1			Model 2
DMU's	Companies	Technical Efficiency (BCC)	(CCR)	Scale Efficiency (CCR / BCC)	Quality & Univers.
1	Telepar	58.5	50.1	85.7	100.0
2	Teleron	52.5	52.5	99.9	100.0
3	Teleacre	36.8	30.8	83.6	100.0
4	Ceterp	45.2	45.1	99.6	100.0
5	CRT	100.0	97.4	97.4	94.9
6	Telern	76.2	71.1	93.4	74.0
7	Telasa	63.5	63.0	99.3	66.5
8	Telepará	74.3	65.0	87.5	65.6
9	CTBC Telecom MG	53.0	48.9	92.2	65.2
10	Telems	24.2	23.7	98.2	62.0
11	Teleamazon	31.7	31.4	99.1	59.5
12	Telemat	48.2	44.5	92.3	59.4
13	Telergipe	75.4	74.6	98.8	59.0
14	Teleamapá	77.4	69.9	90.4	57.9
15	Telaima	54.5	43.9	80.6	56.0
16	Telma	64.9	59.7	91.9	54.5
17	Telegoiás	66.3	58.5	88.2	52.6
18	Sercomtel	61.9	61.4	99.1	50.8
19	CTBC Telecom MS	100.0	36.8	36.8	50.1
20	Telepisa	44.5	44.3	99.4	49.3
21	Telebrasília	55.3	49.3	89.1	47.4
22	CTBC Telecom SP	100.0	100.0	100.0	46.6
23	CTBC Telecom GO	85.5	58.9	68.9	46.2
24	Telerj	55.5	45.3	81.6	45.3
25	CTMR	55.1	52.1	94.7	44.6
26	Telpe	47.4	41.0	86.7	43.9
27	Telesp	100.0	57.0	57.0	43.6
28	Telpa	70.3	65.3	92.9	42.5
29	Telest	71.4	62.5	87.4	41.3
30	Telesc	100.0	97.2	97.2	40.1
31	CTBCampo	54.4	47.8	88.0	39.0
32	Teleceará	53.6	45.6	85.1	30.7
33	Telemig	66.1	55.2	83.5	30.4
34	Telebahia	80.2	66.2	82.5	30.2

In Figure 1 we plot the results obtained by Model 1 (Technical Efficiency) and Model 2.

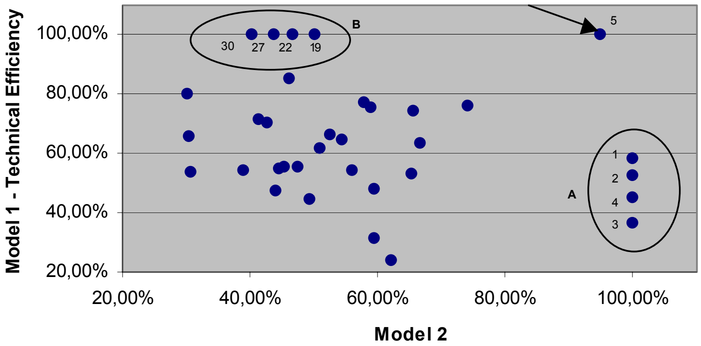

Figure 1 – Model 1 (Technical Efficiency) vs. Model 2

In Figure 1 we first observe the presence of a prominence point marked with the arrow. The company associated to the point (CRT) is a benchmark in terms of technical efficiency for Model 1 and it belongs to the set of 5 most efficient companies with respect to Quality and Universality criteria (Model 2).

Companies belonging to Cluster A (Telepar, Teleron, Ceterp e Teleacre) present low Technical Efficiency levels perhaps as a consequence of large investments on Quality and Universality, for they are benchmarks with respect to Model 2. Together with CRT, these companies are, in principle, candidates for some kind of reward from ANATEL, such as the right to explore other markets. Within the same context, companies belonging to Cluster B (CTBC Telecom MS e SP, Telesp e Telesc) would be the first addressed by ANATEL in order to explain their low performance in terms of Quality and Universality, considering that they are benchmarks in terms of Technical Efficiency regarding Model 1.

In Figure 2 we plot the results obtained by Models 1 and 2 but now considering Scale Efficiency for Model 1.

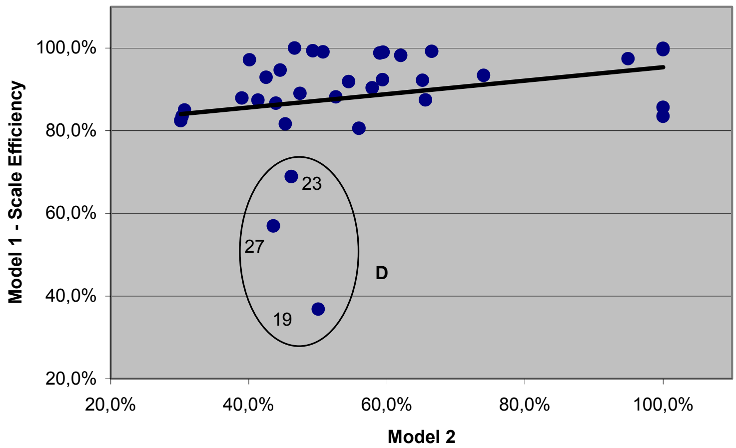

Figure 2 – Model 1 (Scale Efficiency) vs. Model 2

The increasing tendency line shows that companies with larger Scale Efficiency tend to have larger Quality and Universality efficiencies as well, what is desirable and could be considered expected. This is an indicator that expected merges for 2003, provided they are well conducted, are likely to produce better companies overall.

Companies belonging to Cluster D (Telesp, CTBC Telecom MS and GO) show very low values for Scale Efficiency. This indicates that they are currently with wrong sizes for the business, what could be affecting their capability of achieving good Quality and Universality indicators.

Next, in Figure 3, we plot the Scale Efficiency against Technical Efficiency obtained from Model 1.

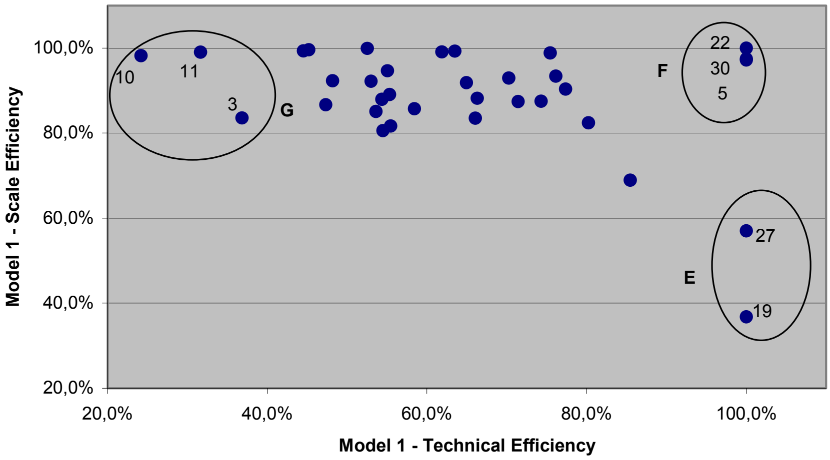

Figure 3 – Model 1: Scale Efficiency vs. Technical Efficiency

It is interesting to point out that in the study conducted by Milioni (2001-b), the 2 companies belonging to Cluster E (Telesp e CTBC Telecom MS) were considered among the best in terms of financial situation. In his work developed for ANATEL, 20 companies among the 34 studied in this article had their 2000 annual balance statement data analyzed using both, a Logit model developed by Scarpel & Milioni (2001), and a DEA model developed by Almeida & Milioni (2001). In none of them Scale Efficiency was taken into consideration. With our present results we can see that these two companies obtained the smallest values for Scale Efficiency, whereas achieving benchmarks in terms of Technical Efficiency. According to Cooper *et al.* (2000), such companies could be facing problems as a consequence of their current size or due to regional specificity.

Cluster F (CTBC Telecom SP, CRT e Telesc) represents the group of most successful companies regarding Model 1. They all appear among top 10 in the study conducted by Milioni (2001-b) and the last 2 belong to top 5.

In the same study Milioni concluded that Teleamazon was the worst company in terms of financial figures. In our study we see that Teleamazon belongs to Cluster G (Teleacre, Teleamazon and Telems) which represents the group of companies with both, low Technical and low Scale efficiencies. These companies would be suggested to focus on efforts to develop theirs performance, such as reducing number of employees.

5. Merger Simulation

Analyzing the results obtained in Model 1, where the companies were evaluated according to both, a CCR and a BCC formulation, we observe that CTBC Telecom MS is the company with the smallest Scale Efficiency among them all, in spite of the fact that it is a benchmark in terms of Technical Efficiency. In order to improve the Scale Efficiency of CTBC Telecom MS we propose a merger with other CTBC Telecom companies (GO, SP and MG). We will evaluate the efficiency of the new company that we will call just CTBC.

On the other hand we have Sercomtel, a company with good Scale Efficiency but Technical Efficiency below the average. For the sake of illustration we will also consider the merger of Sercomtel with Telesc, chosen according to the criteria of geographical proximity, since they are companies located in neighboring states. We will call this second company South.

Following Cooper *et al.* (2000), we conduct the mergers by simply adding all inputs and outputs. The data we used can be found in Table 4A, Appendix.

Next we show the efficiencies resulting from the use of the input-oriented model over the set of 30 companies resultant after the merges:

Table 2 – Efficiency results after Merger (all in %)

DMU's	BCC	CCR	Scale Efficiency
CRT	100.0	100.0	100.0
South *	100.0	100.0	100.0
Telegoiás	70.9	71.0	99.9
Telebahia	84.2	84.4	99.8
Telepar	59.4	59.7	99.6
Teleceará	59.2	59.6	99.5
Telpe	52.7	53.1	99.3
Telest	80.1	80.8	99.2
Telepará	84.4	85.3	98.9
Telemig	66.1	66.9	98.8
Telerj	55.2	56.0	98.5
Telebrasília	58.6	59.6	98.2
CTBCampo	56.9	58.0	98.1
Telma	76.7	78.2	98.1
Telpa	83.8	85.6	97.8
Telern	91.4	93.5	97.7
CTBC *	72.1	74.4	96.9
Telemat	53.4	55.1	96.8
Telergipe	96.0	100.0	96.0
Telasa	81.0	84.3	96.0
Telepisa	56.8	59.5	95.5
Teleron	67.1	71.0	94.5
Teleamazon	40.3	42.7	94.3
Telems	27.9	30.4	91.8

Table 2 (cont.) – Efficiency results after Merger (all in %)

DMU's	BCC	CCR	Scale Efficiency
Ceterp	55.1	62.3	88.5
Teleamapá	86.7	100.0	86.7
CTMR	63.6	80.4	79.1
Telesp	68.0	100.0	68.0
Teleacre	39.2	60.7	64.6
Telaima	54.8	100.0	54.8

* resultant from Merger

Analyzing the results presented in Table 2 we observe that the Technical Efficiency of CTBC (72,1%) falls below the average of the former CTBC Telecom companies, which was equal to 84,6%. The Scale Efficiency, however, increases to 96,9% with respect to the former average of 74,5%. This results are the same as those registered by Cooper *et al.* (2000) in a Bank Merger Simulation, i.e., when two locally (BCC) efficient DMU's merge to form a new DMU, the new DMU is neither locally (BCC) nor globally (CCR) efficient, if increasing returns-to-scale prevails at all three DMU's.

Table 3 – CTBC's efficiency results after Merger (all in %)

DMU's	BCC	CCR	Scale Efficiency
CTBC *	72.1	74.4	96.9
CTBC Telecom (MS)	100.0	36.8	36.8
CTBC Telecom (GO)	85.5	58.9	68.9
CTBC Telecom (MG)	53.0	48.9	92.2
CTBC Telecom (SP)	100.0	100.0	100.0
Average	84.6	61.2	74.5

* resultant from Merger

Results presented in Table 3 suggest that a simple Merger would not be sufficient in this case, in the sense that a reduction in the input would be also necessary in order to improve Technical Efficiency.

In the second Merge (South) the opposite was observed, since the resulting company became a benchmark both in Technical and Scale Efficiencies.

Table 4 – South's efficiency results after Merger (%)

DMU's	BCC	CCR	Scale Efficiency
South *	100.0	100.0	100.0
Telesc	100.0	97.2	97.2
Sercomtel	61.9	61.4	99.1

* resultant from Merger

6. Final Remarks

In this work we investigated the relative efficiency of telephone companies using Data Envelopment Analysis, a tool that can be used by ANATEL as additional support in its continuous task of evaluating the performance of the companies currently providing Landline Telephone Services in Brazil. Our results enabled us to put in evidence, for instance, the companies that could be considered candidates for an eventual reward by ANATEL, such as the concession to explore other areas. We also illustrated how to estimate the potential efficiency improvement through the simulation of corporate merger.

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Appendix

Table 1A – Model 1 Data

	DMU's	L	PT	AI	MN	P	AS
1	Telerj	13,707	99,951	3,692,804	66,715	898,157	3,348,768
2	Telemig	10,947	73,407	2,895,328	104,585	650,575	2,746,105
3	CTBC Telecom (MG)	2,373	7,465	464,154	17,858	83,923	362,485
4	Telest	1,837	16,690	561,042	25,006	133,454	503,880
5	Telebahia	4,785	54,439	1,406,159	93,584	289,541	1,302,615
6	Telergipe	314	6,776	170,519	8,366	32,158	159,206
7	Telasa	256	11,681	251,350	6,268	45,267	227,226
8	Telpe	2,821	41,304	831,171	33,575	129,859	714,117
9	Telpa	686	13,519	328,803	16,296	51,858	293,823
10	Telern	556	12,607	329,721	13,949	58,218	294,634
11	Teleceará	3,030	34,874	791,541	32,330	170,784	761,737
12	Telepisa	649	10,554	246,330	6,971	41,227	236,549
13	Telma	868	15,296	321,770	17,600	58,613	299,971
14	Telepará	1,050	23,521	532,904	20,711	114,351	513,635
15	Teleamapá	220	2,055	71,470	4,379	12,061	69,287
16	Teleamazon	1,039	10,420	315,052	4,470	47,623	301,052
17	Telaima	183	1,602	48,120	1,898	7,402	46,024
18	Telesc	3,461	25,623	1,193,985	92,233	182,877	1,049,553
19	Telepar	10,659	46,327	2,227,874	99,189	382,924	1,710,688
20	Sercomtel	851	2,203	154,499	7,281	37,475	139,190
21	Telems	2,633	10,550	472,702	9,766	36,771	387,969
22	CTBC Telecom (MS)	44	163	7,788	165	1,629	6,143
23	Telemat	1,950	13,745	451,478	18,020	80,212	328,261
24	Telegoiás	4,859	38,487	1,155,173	71,272	226,598	957
25	CTBC Telecom (GO)	86	588	30,402	1,194	4,391	22,076
26	Telebrasília	3,278	20,175	884,852	20,617	199,460	749,120
27	Teleron	718	6,345	253,011	9,766	36,771	180,469
28	Teleacre	313	2,924	93,604	1,815	11,903	68,330
29	CRT	9,731	53,347	2,101,056	222,006	404,249	1,826,485
30	CTMR	469	2,015	120,935	3,492	23,321	99,406
31	Telesp	49,550	223,445	11,185,983	487,631	2,289,167	9,413,366
32	Ceterp	1,307	3,017	217,837	6,483	47,654	184,837
33	CTBC Telecom (SP)	374	2,784	209,829	10,429	35,251	164,842
34	CTBCampo	5,294	21,577	1,081,897	15,537	318,203	964,195

Table 2A – Model 2 Data (Quality)

	Jul/98					Dez/00				
	(TR) %	(PT) %	(EC) /1000	(LC) %	(TD) %	(TR) %	(PT) %	(EC) /1000	(LC) %	(TD) %
Telerj	7.1	17.9	11.1	58.4	52.4	4.6	10.8	7.1	17.9	11.1
Telemig	2.8	24.0	5.9	60.4	68.5	2.6	11.0	2.8	24.0	5.9
Telest	2.8	22.0	9.1	55.7	77.7	2.6	10.8	2.8	22.0	9.1
Telebahia	1.9	7.5	5.4	61.6	79.3	2.8	11.1	1.9	7.5	5.4
Telergipe	4.7	34.0	10.0	46.4	58.9	2.3	11.7	4.7	34.0	10.0
Telasa	4.9	27.0	4.2	46.6	60.5	2.4	10.6	4.9	27.0	4.2
Telpe	6.2	33.1	7.6	53.8	78.0	4.5	8.4	6.2	33.1	7.6
Telpa	6.7	44.5	5.4	54.5	73.4	4.5	10.5	6.7	44.5	5.4
Telern	3.5	19.3	10.7	54.7	75.5	2.2	8.5	3.5	19.3	10.7
Teleceará	3.4	20.2	11.4	56.8	75.5	2.2	8.5	3.4	20.2	11.4
Telepisa	2.4	24.4	6.9	53.6	61.5	2.2	12.4	2.4	24.4	6.9
Telma	4.8	25.3	6.3	44.4	87.3	2.8	8.7	4.8	25.3	6.3
Telepará	7.0	19.0	12.8	47.7	88.3	3.8	9.9	7.0	19.0	12.8
Teleamapá	7.2	22.7	26.3	45.3	97.0	2.3	6.7	7.2	22.7	26.3
Teleamazon	6.8	12.8	9.0	41.3	67.7	2.1	9.6	6.8	12.8	9.0
Telaima	3.7	18.7	5.3	50.0	72.8	1.4	6.0	3.7	18.7	5.3
CTBC Telecom MG	1.9	19.0	8.2	62.8	53.0	1.9	8.6	1.9	19.0	8.2
Telebrasília	2.2	4.1	6.5	50.4	69.0	2.6	8.8	2.2	4.1	6.5
CTMR	3.1	34.3	8.7	56.3	97.5	1.2	5.4	3.1	34.3	8.7
Telesc	3.1	20.0	3.0	52.3	88.0	2.1	7.8	3.1	20.0	3.0
Telepar	3.0	28.9	8.7	62.1	60.3	2.1	8.6	3.0	28.9	8.7
Telems	3.6	32.2	7.7	58.3	77.5	1.5	10.1	3.6	32.2	7.7
Telemat	6.0	32.0	9.0	69.1	80.5	2.0	12.4	6.0	32.0	9.0
Telegoiás	2.7	34.5	5.5	57.6	74.3	2.4	13.0	2.7	34.5	5.5
Teleron	5.1	19.8	69.0	53.2	73.0	2.3	12.1	5.1	19.8	69.0
Teleacre	5.5	26.1	11.5	54.5	77.4	2.3	9.6	5.5	26.1	11.5
CRT	8.6	27.3	33.7	53.5	6.9	2.4	7.3	8.6	27.3	33.7
Sercomtel	2.6	80.0	6.5	63.1	78.3	2.0	5.5	2.6	80.0	6.5
CTBC Telecom MS	0.6	13.9	4.8	88.7	81.5	2.2	8.7	0.6	13.9	4.8
CTBC Telecom GO	1.7	14.1	7.2	60.6	47.4	1.0	5.6	1.7	14.1	7.2
Telesp	2.9	24.2	8.1	56.7	64.8	2.3	5.8	2.9	24.2	8.1
Ctbcampo	4.3	8.1	8.0	65.5	62.2	1.9	10.1	4.3	8.1	8.0
Ceterp	4.0	63.8	3.1	60.2	69.2	1.2	5.2	4.0	63.8	3.1
CTBC Telecom SP	1.5	17.1	4.2	65.8	55.9	1.7	6.4	1.5	17.1	4.2

Table 3A – Model 2 Data (Universality)

	FA $_{98}$	**PT** $_{98}$	**FA** $_{00}$	**PT** $_{00}$
Telerj	1,927,000	65,600	3,692,804	99,951
Telemig	1,811,000	48,825	2,895,328	73,407
CTBC Telecom (MG)	273,643	4,427	464,154	7,465
Telest	292,283	9,880	561,042	16,690
Telebahia	819,395	32,200	1,406,159	54,439
Telergipe	93,879	3,295	170,519	6,776
Telasa	136,798	4,142	251,350	11,681
Telpe	411,043	26,327	831,171	41,304
Telpa	202,252	7,959	328,803	13,519
Telern	124,174	4,792	329,721	12,607
Teleceará	534,098	22,000	791,541	34,874
Telepisa	133,886	4,975	246,330	10,554
Telma	182,781	6,381	321,770	15,296
Telepará	266,179	8,679	532,904	23,521
Teleamapá	40,216	910	71,470	2,055
Teleamazon	157,118	4,880	315,052	10,420
Telaima	28,633	722	48,120	1,602
Telesc	609,716	15,360	1,193,985	25,623
Telepar	1,029,415	27,596	2,227,874	46,327
Sercomtel	110,837	1,372	154,499	2,203
Telems	233,875	5,400	472,702	10,550
CTBC Telecom (MS)	4,787	53	7,788	163
Telemat	231,031	8,617	451,478	13,745
Telegoiás	542,197	19,200	1,155,173	38,487
CTBC Telecom (GO)	15,045	372	30,402	588
Telebrasília	566,511	8,263	884,852	20,175
Teleron	82,125	2,668	253,011	6,345
Teleacre	36,000	753	93,604	2,924
CRT	1,194,000	32,552	2,101,056	53,347
CTMR	79,951	1,287	120,935	2,015
Telesp	5,294,217	156,599	11,185,983	223,445
Ceterp	154,600	1,924	217,837	3,017
CTBC Telecom (SP)	105,761	1,337	209,829	2,784
CTBCampo	563,024	13,959	1,081,897	21,577

Table 4A – Data of 30 Companies after Merger

	L	PT	AI	MN	P	AS
Telerj	13,707	99,951	3,692,804	3,348,768	66,715	898,157
Telemig	10,947	73,407	2,895,328	2,746,105	104,585	650,575
Telest	1,837	16,690	561,042	503,880	25,006	133,454
Telebahia	4,785	54,439	1,406,159	1,302,615	93,584	289,541
Telegirpe	314	6,776	170,519	159,206	8,366	32,158
Telasa	256	11,681	251,350	227,226	6,268	45,267
Telpe	2,821	41,304	831,171	714,117	33,575	129,859
Telpa	686	13,519	328,803	293,823	16,296	51,858
Telern	556	12,607	329,721	294,634	13,949	58,218
Teleceará	3,030	34,874	791,541	761,737	32,330	170,784
Telepisa	649	10,554	246,330	236,549	6,971	41,227
Telma	868	15,296	321,770	299,971	17,600	58,613
Telepará	1,050	23,521	532,904	513,635	20,711	114,351
Teleamapá	220	2,055	71,470	69,287	4,379	12,061
Teleamazon	1,039	10,420	315,052	301,052	4,470	47,623
Telaima	183	1,602	48,120	46,024	1,898	7,402
Telepar	10,659	46,327	2,227,874	1,710,688	99,189	382,924
Telems	2,633	10,550	472,702	387,969	9,766	36,771
Telemat	1,950	13,745	451,478	328,261	18,020	80,212
Telegoiás	4,859	38,487	1,155,173	957,000	71,272	226,598
Telebrasília	3,278	20,175	884,852	749,120	20,617	199,460
Teleron	718	6,345	253,011	180,469	9,766	36,771
Teleacre	313	2,924	93,604	68,330	1,815	11,903
CRT	9,731	53,347	2,101,056	1,826,485	222,006	404,249
CTMR	469	2,015	120,935	99,406	3,492	23,321
Telesp	49,550	223,445	11,185,983	9,413,366	487,631	2,289,167
Ceterp	1,307	3,017	217,837	184,837	6,483	47,654
Ctbcampo	5,294	21,577	1,081,897	964,195	15,537	318,203
CTBC	2,877	11,000	712,173	555,546	29,646	125,194
South	4,312	27,826	1,348,484	1,188,743	99,514	220,352