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UNIVERSIDADE FEDERAL  
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INSTITUTO DE ECONOMIA

Brazilian Telecommunications: Experience and Future Perspectives\*

nº 451

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Dezembro de 2000

Textos para Discussão

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43 - 017073

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\* The author acknowledges Hélio Alfinito (then at Telebrás) and Pedro E. Carvalho (Anatel) for helping in obtaining data from these two institutions. Conversations with Evandro Silva (BNDES) were also useful, but the usual caveats apply.

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 Instituto de Economia - UFRJ

UFRJ/CCJE/BIBLIOTECA EUGÊNIO GUDIN  
 DATA: 1/1/2000

Nº DE 505382-X

NÚMERO NO SISTEMA: 481460

Ficha catalográfica - CÓDIGO DE BARRAS: 481452

RESENDE, Marcelo

Brazilian Telecommunications: past experience and future perspectives.  
 / Marcelo Resende

48p. 21cm. - (Coleção de Estudos em Economia IE/UFRJ; n° 451)

Bibliografia:

1. Telecomunicações - Brasil. I. Título. II. Série.

2. Telecomunicações - privatização - Brasil.

O Programa Editorial do Instituto de Economia (IE/FEA/UFRJ), através do Núcleo de Estudos em Didática (NED) e do Núcleo de Estudos em Documentação (NEDOC), publica artigos, ensaios, material de apoio aos cursos de graduação e pós-graduação e trabalhos de pesquisas produzidos por seu corpo docente.

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## SUMÁRIO

O capítulo acompanha a evolução das telecomunicações no Brasil do modelo de provisão estatal com a Telebrás desde os anos 70 até o novo modelo emergindo da privatização do sistema em Julho de 1998. Diferentes indicadores no nível agregado e no nível de firma evidenciaram universalização e eficiência insatisfatórios no regime anterior. O novo modelo que se desenvolve em torno de uma agência regulatória independente mostra resultados promissores em termos de expansão da rede e os desafios referem-se ao esforço de garantir acesso universal, à consolidação de padrões apropriados de qualidade de serviço e ao funcionamento efetivo da competição nos diferentes tipos de serviço.

## ABSTRACT

The chapter traces the evolution of Brazilian telecommunications from a State provision model with Telebrás since the 70s to the new model emerging with the privatisation of the system in July 1998. Different aggregate and firm level indicators showed unsatisfactory efficiency and service access in the previous regime. The new model, which evolves around an independent regulatory agency, displays encouraging results in terms of network expansion and the challenges refer to the effort to guarantee universal access, the consolidation of appropriate service quality patterns and the actual functioning of competition in the different types of services.

## 1. INTRODUCTION

State intervention in Brazil has been historically associated with the process of filling empty spaces left by the private sector. In fact, the emergence of the State as an entrepreneur in Brazilian infra-structure sectors reflected to a great extent the scarcity of funds and/or lack of attractive returns in the referred sectors which made the private provision of the related services untenable at that occasion [see Suzigan (1976) and Trebat (1983)]. Recently, the privatisation process in Brazil has defined a turning point in terms of the role of the State in the economy. The major arguments put forward referred to inadequate levels of productive efficiency by State owned enterprises and decreasing investment capacity by those firms [see Abreu and Werneck (1993) and Pinheiro and Giambiagi (1994) for an overview]. The possible positive impacts accruing from privatisation and an increasingly competitive environment in the specific context of telecommunications have been discussed in relation to developing economies. A cross-country econometric study advanced by Ros (1999) indicated that network expansion (as measured by main lines per 100 inhabitants) is significantly higher in countries with high proportion of private ownership, though similar evidence does not prevail for countries with GDP per capita of less than \$ 10000. Moreover, Jayakar (1999) obtained econometric evidence on the US for the period 1876-1982 indicating that competition has a positive role in determining telephone penetration even in early stages of network development. This result is suggestive for developing countries where competition is being introduced like Brazil.

In the case of Brazilian telecommunications the privatisation process has attracted intense media coverage not only because of the dynamic character and pervasiveness of the sector in any modern economy but also because of the large monetary magnitudes involved. In July of 1998 the Telebrás system was privatised by means of the sale by the amount of US\$ 19 billion in one of the largest privatisations ever [see Dores (1999), Novaes (1999) and Pires (1999) for details]. The gradual emergence of government failures in terms of fiscal crisis, bureaucratic decay and opportunistic behaviours, indicated that market failures are not easily suppressed by means of direct State intervention

[see Werneck (1996)]. One can therefore witness a shift from the role of the State as an entrepreneur to the State as a regulator. The present chapter intends to trace that path in the context of the Brazilian telecommunications sector. In particular one will be interested in characterizing the exhaustion of the institutional design based on the public provision of telecommunications and discuss the new model that emerges after the privatisation of the Telebrás system. In the latter case, one will focus on the emerging regulatory framework and future challenges for the sector. The remaining of the chapter is organized as follows. The second section discusses the pre-privatisation period with aggregate and firm-specific indicators and also describes the main events defining the institutional design of that period. The third section considers the new telecommunications scenario after the privatisation stressing in particular issues on the institutional and regulatory design. The fourth section brings some final comments.

## 2. BRAZILIAN TELECOMMUNICATIONS: THE PRE-PRIVATISATION PERIOD

### 2.1- A general overview

Telecommunications in Brazil exhibited a large expansion during the 70s

with a State provision model which would display signs of exhaustion during the 80s especially with respect to the lack of investment capacity. Historically, the telecommunications sector in Brazil was characterized by a large number of telephone companies. In fact, by the end of the 50s and during the 60s there were approximately 1000 companies as concessions were granted by the federal, state and local governments without an appropriate coordination between the different networks. The bulk of telecommunications services provision was in the hands of subsidiary of foreign companies, examples including Companhia Telefônica Brasileira-CTB (owned by Canadian Traction, Light and Power Company) and Companhia Telefônica Nacional-CTN (owned by ITT). The first, for example, accounted for 62% of fixed telephone

lines in Brazil. It turned out, however, that these foreign firms only displayed some commitment with network expansion in urban areas whereas small localities had carriers that were not capable of meeting the repressed demand challenges. The necessity of a coordinated effort in telecommunications expansion was considered by means of the definition of a State-based telecommunications model. This provision model aimed at enabling a faster network expansion and define a coherent coordination between the different local networks. The emergence of this new institutional model was made possible by new legal elements by the beginning of the 60s and by the nationalization of important foreign telephone companies by the end of that decade. The main events affecting the Brazilian telecommunications sector before privatisation are summarised in table 1.

Table 1

Telecommunications Policy: Some Important Events (Pre-Privatization Period)

- 1962: Brazilian Telecommunications Code (Law 4117): defined the general rules that would define a State-based institutional design in terms of a regulatory body, a State-controlled long-distance operator and transfer schemes to sustain funding;
- 1963: Decree 52026: approved the general regulations for execution of the Brazilian Telecommunications Code
- 1965: Embratel starts to operate
- 1967: Decree no. 200 creates (among others) the Ministry of Communications; National Telecommunications Fund starts to operate;
- 1972: Creation of Telebrás (a holding company comprising 26 state local operators, 1 municipal local company and a long-distance operator (Embratel))
- 1988: Constitution establishes the public monopoly in telecommunications confirming the situation that had been prevailing under the Telebrás system.
- 1995: Constitutional amendment no. 8 ends the requirement of public monopoly in telecommunications and therefore create conditions for future privatizations.
- 1996: Law 9295 (Minimum or Specific Law): enables the privatization of value-added services, services via satellite, data transmission and the B-band mobile service
- General Telecommunications Norm (NGT 20/96): defines the exploration areas for mobile cellular services and other relevant details
- 1997: Ministerial order no. 392: increased the revenue sharing of leading local telephone companies (e.g. TELEMIG, TELERJ and TELESP) with Embratel
- Law 9472 (General Telecommunications Law): defines the institutional design for the sector and establishes the regulatory agency Anatel. The new regulatory agency Anatel starts to operate
- Firms begin to operate in the B-band segment of the mobile cellular service sector

The 1962 Brazilian Telecommunications Code together with the 1963 decree which approved the corresponding general regulations established the basis for a State provision model in telecommunications.

In fact, these legal instruments established five basic elements as described by Novaes (1999):

- i) defined the attributes of the State;
- ii) defined telecommunications services and divided them into categories;
- iii) created the National Telecommunications Council (CONTEL), a regulatory agency that would be later extinct in 1990;
- iv) authorized the creation of a State-controlled company for long-distance telecommunications services enabling the creation of Embratel, that would be responsible for a whole set of services including inter-state telephone, radio communication, satellite services and international calls;
- v) established the National Telecommunications Fund (FNT) in terms of surcharge on telecommunications services design to fund Embratel.

The final component in the definition of National System of Telecommunications (SNT) conceived by the code was completed with the creation of Telebrás in 1972 a State-controlled holding company that comprised 26 state and 1 municipal local telephone companies and 1 long-distance operator (Embratel)<sup>1</sup>. These elements defined a State-based sector where a holding company controlled state local telephony companies and a long-distance operator under strong control of the related ministries (Communications, Finance and Planning ministries). Since its beginning the regulatory body had very limited autonomy and not rarely the definition of tariff levels reflected macroeconomic stabilisation goals such as inflation control. In fact, tariff levels required approval from the Communication, and the Finance Ministries whereas investment plans had to be subject to final approval from the Planning Ministry based on previously budget-approved items rendering the whole process altogether complex. The regulatory framework comprised traditional rate-of-return regulation (ROR) for setting telephone tariffs with its associated shortcomings and a set of arbitrary interconnection rules. Indeed, the basic rule for interconnection was based on a revenue sharing scheme based in mutual traffic. A percentage of the revenue of the local operator originating the long-distance call was assigned to the long-distance operator Embratel. Under such scheme,



firms that underperformed benefited from a smaller sharing factor what constituted an incentive to inefficient firms. Moreover, there is anecdotal evidence indicating that a criterion based on the rate-of-return has at times induced accounting manipulations in the value of assets in order to assure a smaller rate-of-return and therefore a smaller sharing of revenues with Embratel. This interconnection scheme induced distortions by favouring firm with weak operational performance? Finally, it is worth mentioning that inter-state long-distance was handled through Embratel and also the great majority of intra-state long-distance calls. In the case of different cities situated within a so-called conurbation, the local company operated the call directly and charged a higher (than the intra-city calls) tariff. Having described the basic institutional and regulatory design under the Telebrás system we should proceed by examining the evolution of different indicators during that period. First, it is useful to consider the historical evolution of selected aggregate indicators as presented in table 2.<sup>3</sup>

The first striking fact pertains the rapid expansion of the network as indicated by the number of fixed terminals and an explosive growth of the number of cellular lines by the end of the period. The growth of fixed terminals observed in the table, however, was surpassed by the rapid growth of demand in terms of local pulses and the resulting traffic increase reflected a still significant repressed demand [see Fiuza and Neri (1998)].

Table 2  
Brazilian Telecommunication - Selected Indicators for Telebrás

	Fixed lines installed (Millions of lines)	Fixed lines in service (Millions of lines)	Contracted fixed lines (Thousands of lines)	Cellular lines in service (Thousands of lines)	Pay phones (Thous. of pay phones)	Townships with telecommunication services	Fixed installed lines per 100 inhab.	Fixed lines installed per employee (Employees/1000 lines)	Investment - Total (t) (Millions of US\$)	Congestion ratio (%)	Network digitization (% of main lines)
1972	1.4	1.2	-	-	10.3	2.2	-	-	-	33.0	-
1973	1.6	1.4	-	-	13.5	2.2	-	35.0	-	46.0	-
1974	1.9	1.6	1,038.0	-	13.7	2.6	-	34.0	796.1	40.9	-
1975	2.2	1.8	479.1	-	18.3	2.7	-	33.6	1,219.5	36.2	-
1976	2.9	2.3	304.4	-	24.0	2.9	-	27.0	1,648.1	33.1	-
1977	3.6	2.8	200.8	-	28.9	3.0	-	22.0	1,565.9	26.4	-
1978	4.2	3.4	283.7	-	42.7	3.3	-	21.0	1,454.1	23.6	-
1979	4.7	3.9	280.1	-	42.7	3.3	-	18.9	1,358.0	14.0	-
1980	5.1	4.5	367.0	-	49.8	3.8	4.6	18.0	932.3	9.5	-
1981	5.4	4.9	311.3	-	56.0	4.7	4.8	17.0	1,330.0	6.4	-
1982	5.8	5.3	439.9	-	63.9	6.1	5.0	16.2	1,323.3	6.5	-
1983	6.2	5.7	295.1	-	71.2	7.1	5.3	15.3	991.9	6.1	-
1984	6.7	6.2	403.8	-	87.3	8.0	5.6	14.0	863.7	6.8	-
1985	7.0	6.6	635.2	-	98.5	8.5	5.7	14.0	918.3	8.2	-
1986	7.3	6.8	903.7	-	141.3	8.8	5.9	13.2	1,245.0	16.6	-
1987	7.7	7.2	638.7	-	172.3	11.4	6.1	12.8	1,447.7	24.9	-
1988	8.2	7.6	210.1	-	200.4	11.9	6.4	11.9	1,977.1	26.7	6.0
1989	8.8	8.0	348.5	-	220.7	12.8	6.7	11.1	2,599.0	31.1	10.3
1990	9.3	8.5	247.9	-	227.0	13.9	7.0	10.0	2,171.4	25.9	13.7
1991	9.8	9.2	636.7	6.7	219.3	14.5	7.2	9.0	2,311.0	23.6	16.1
1992	10.6	9.8	347.7	30.7	243.2	15.4	7.6	8.4	3,053.6	13.7	22.3
1993	11.3	10.5	1,125.1	180.2	261.7	16.1	8.0	8.2	3,026.7	10.8	27.9
1994	12.0	11.2	1,271.9	574.0	325.1	17.5	8.4	7.9	3,362.0	9.7	35.7
1995	13.3	12.1	1,653.5	1,260.5	347.3	18.9	9.2	6.9	4,217.6	9.6	46.7
1996	14.9	13.5	4,657.8	2,451.0	406.0	20.6	10.2	6.0	6,792.5	8.3	57.1
1997	17.0	15.4	2,856.0	4,023.1	484.1	22.0	11.5	5.1	6,929.2	7.0	69.0
07/98	18.2	16.5	1,103.0	4,633.2	506.9	(*)22.9	12.3	4.4	4,294.2	5.7	-

Notes: Annual Report - Telebrás (1998) and ITU (1998), with blank spaces in the table indicating non-available data, independent operators (which represented approximately 5% of the telephone lines) are not included in the presented information.

(\*) Current values translated by the average US dollar of each year.

(\*) Projection.



The inspection of table 2 shows that despite a positive evolution, many indicators displayed unsatisfactory levels. In particular, telephone density, congestion rate and digitalisation of the network led to unfavourable comparisons when one takes international data from the International Telecommunications Union-ITU and other sources as reference.<sup>4</sup> Telephone density exhibited a slow improvement over the period, however, if one considers the 1988-97 mean for comparison with international figures from ITU the results are not good. The mean value for Brazil of 8.22 contrasts with an analogue value of 12.84 for Argentina, 7.49 for Mexico for the same time-period. If one considers some developed countries the results would differ more as one has a mean value of 46.94 for Germany and 47.13 for the United Kingdom, for example. This limited telephone penetration can be further investigated by considering data from the Brazilian annual household survey (PNAD from IBGE). The question regarding telephone line possession appeared first in the 1992 issue of PNAD. The percentages of households with fixed telephone lines are presented in table 3 for the period 1992-99 (except for 1994 when the survey did not occur). The results are displayed according to geographic regions and states.<sup>5</sup>

The evidence indicates a relatively fast growth in telephone access towards the end of the decade, but the values are still very low. As expected, the figures are higher for more developed regions and states (for example some states in the south and southeast regions and the Brazilian capital) and despite some occasional non-monotonic movements associated with sampling variability, the trend is clear: the improvement is still insufficient and poorer regions have to face a greater challenge in terms of universal access

Additional relevant information can be obtained from table 2. The congestion indicator greatly worsened during the 80s to later recover near the transition period just before the privatisation in 1998. Even though, international figures are not readily available to enable comparisons it is clear that the levels of service quality were inadequate during the 80s.

Table 3  
Households with fixed telephone lines-1992/99 (%)

Geographic region/states	1992	1993	1995	1996	1997	1998	1999
North	17.5	16.8	19.8	21.0	22.4	26.2	32.0
Northeast	9.3	10.2	11.5	13.8	15.9	18.0	21.0
Alagoas	8.3	11.5	12.2	14.0	17.8	18.6	21.5
Bahia	9.6	10.7	12.2	14.6	15.8	17.5	19.9
Ceará	10.4	11.2	12.2	15.5	19.5	22.1	23.3
Maranhão	6.6	7.2	7.8	9.1	11.0	12.2	12.5
Paraíba	12.3	14.8	15.4	16.8	20.9	23.5	27.8
Pernambuco	7.4	8.0	9.0	12.5	13.7	16.5	22.8
Piauí	9.8	9.3	12.8	13.2	15.1	17.1	16.0
Sergipe	12.6	11.7	13.7	16.7	15.3	18.0	22.9
Mid-West	19.2	20.5	25.9	28.5	32.2	36.9	41.8
Distrito Federal	44.1	49.2	55.6	61.8	65.1	70.5	70.7
Goiás	14.0	14.8	20.5	23.5	26.9	30.5	35.6
Mato Grosso	12.1	12.9	17.3	18.2	22.8	28.4	32.7
Mato Grosso do Sul	17.6	17.4	22.1	23.7	25.1	31.4	40.3
Southeast	24.8	25.5	28.0	31.9	34.3	38.6	45.4
Espírito Santo	15.6	18.6	19.8	21.8	24.5	25.4	31.0
Minas Gerais	19.4	20.4	22.2	25.3	29.4	32.9	38.9
Rio de Janeiro	24.2	23.0	25.9	28.6	27.8	30.2	37.8
São Paulo	28.2	29.4	32.3	37.1	40.1	45.8	52.7
South	18.8	19.7	22.8	25.9	28.8	35.4	42.0
Paraná	22.7	22.6	25.8	27.9	29.2	33.3	38.8
Santa Catarina	17.3	18.5	22.7	26.3	31.0	37.2	42.9
Rio Grande do Sul	16.2	17.8	20.4	23.9	27.3	36.4	44.4
Brazil	19.0	19.8	22.3	25.4	27.9	32.0	37.6

Source: author's construct upon different issues of PNAD-IBGE

Network digitalisation constitutes a more recent phenomenon in Brazil, but the movement towards modernization has been relatively fast. In 1997 one reached 69% of digitalisation. Even though there was a

rapid improvement, the indicator is inferior if compared to the corresponding values for Argentina (98.7%), Mexico (90.1%), Germany (100%) and United Kingdom (100%), for example.

The remaining indicators in that table show that there was a fast, yet insufficient, expansion and modernization of the network. When one examines the evolution of investment in real terms it is clear the erratic and slow growing pattern indicating stagnation during the 80s with some posterior recovery in the 90s. It is worthwhile to mention the behaviour of funding sources over time. In fact, Almeida and Crossetti (1997) point out that the lack of investment in the 80s largely reflected tariff compression for price level stabilisation purposes, strict restrictions in obtaining loans and depletion of fiscal funds as the National Telecommunications Fund which ended being extinct in 1986 (and often had been deviated to other sectors in the previous years). One of the reasons for this state of affairs was related to substantial cross-subsidies between long-distance and local calls. The fact that only local calls were included in the price index provided an extra motivation for compressing the tariffs on local calls.

## 2.2- Firm Level Analysis

In the present section we complement the previous analysis by considering firm level detailed data, which is available from Telebrás for the period 1994-97 in an annual basis. First, in order to further characterize network modernization it is useful to present data on the deployment (in km) of fibre optics conduits. The results are presented in table 4.

The introduction of fibre optics can be seen to be a recent trend in Brazilian local telephony. Other aspect that deserves mention is the high heterogeneity of the sample with some particular carriers with very reduced effort with respect to that variable. A second relevant aspect for network modernization refers to R&D effort. Table 5 presents evidence on R&D intensity at firm level.

Table 4  
Telebrás system-km of fiber

Carrier	1994	1995	1996	1997
TELERON	0	0	609	9,835
TELEACRE	0	0	209	365
TELAMAZON	0	0	2,070	3,858
TELAIMA	0	0	292	333
TEEPARÁ	0	0	2,699	12,354
TELEAMAPÁ	0	0	72	72
TELMA	0	0	6,552	34,776
TELEPISA	0	0	1,739	2,927
TELECEARÁ	0	0	7,972	17,418
TELERN	0	0	4,333	6,729
TELPA	0	0	1,444	1,304
TELPE	0	0	11,689	23,353
TELASA	0	0	1,333	4,400
TELERGIPE	0	0	1,384	1,384
TELEBAHIA	0	0	29,078	35,071
TELEMIG	0	0	104,500	122,771
TELEST	0	0	12,744	19,590
TELERJ	0	0	22,018	23,442
TELESP	0	0	145,249	171,377
CTBC	0	0	25,094	29,087
TELEGOIÁS	0	0	39,819	76,046
TELEMAT	0	0	705	4,862
TELEMS	0	0	942	12,706
TELEBRASÍLIA	0	0	14,810	18,978
TELEPAR	0	0	16,953	32,128
TELESC	0	0	36,200	52,742
CTMR	0	0	652	1,938
EMBRATEL (1)	37597	127,309	281,241	415,761

Source: Telebrás

(1) Long-distance operator

Table 5  
Telebrás system-R&D intensity (1)

Carrier	1994	1995	1996	1997
TELERON	0.0077	0.0089	0.0098	0.0057
TELEACRE	0.0082	0.0102	0.0073	0.0067
TELAMAZON	0.0139	0.0134	0.0109	0.0074
TELAIMA	0	0.0111	0	0.0643
TELEPARÁ	0.0109	0.0088	0.0093	0.0065
TELEAMAPÁ	0	0.0094	0.0068	0.0061
TELMA	0	0	0.0084	0.0060
TELEPISA	0.0311	0.0250	0	0.0066
TELECEARÁ	0.0068	0.0087	0.0067	0.0061
TELERN	0.0220	0.0087	0.0128	0.0058
TELPA	0.0108	0.0085	0.0083	0
TELPE	0.0142	0.0110	0.0137	0.0059
TELASA	0.0110	0.0081	0.0112	0.0066
TELERGIPE	0	0.0091	0.0071	0.0006
TELEBAHIA	0.0149	0	0	0.0066
TELEMIG	0.0044	0.0125	0.0114	0.0054
TELEST	0.0088	0.0095	0.0119	0
TELERJ	0.0123	0	0.0076	0.0081
TELESP	0	0	0.0116	0.0074
CTBC	0	0.0102	0.0158	0.0059
TELEGOIÁS	0.0106	0.0098	0.0076	0.0059
TELEMAT	0	0.0100	0.0107	0.0054
TELEMS	0.0147	0.0190	0.0078	0.0061
TELEBRASÍLIA	0.0114	0.0100	0.0089	0.0073
TELEPAR	0.0112	0.0107	0.0081	0.0061
TELESC	0.0075	0.0090	0.0151	0.0052
CTMR	0.0102	0.0090	0.0076	0.0063
EMBRATEL (2)	0.0131	0.0115	0.0127	0.0067

Source: author's construct upon Telebrás data

(1) R&D expenses divided by telecommunication services revenues.

(2) Long-distance operator

The inspection of the previous table indicates, once more, a large degree of heterogeneity, but most importantly reveals modest R&D efforts by telecommunication carriers in Brazil. In fact, if one takes as reference previous evidence on Brazilian firms in general [see Resende and Hasenclever (1998)] a typical mean value for R&D intensity would

be 3% which as a rule exceeds the values for telephony and one cannot detect any obvious trend of improvement over time in terms of the data. It is worth noting that the aforementioned mean is already low for international standards.

Finally, an efficiency measurement effort will be undertaken for the local telephone companies under the Telebrás system. The flexible approach of Data Envelopment Analysis (DEA), initially advanced by Charnes, Cooper and Rhodes (CCR, 1978), impose no restrictions on the technology, other than convexity and piece-wise linearity. This initial approach contemplates the constant returns to scale case. The model was extended to the variable returns to scale case by Banker, Charnes and Cooper (BCC, 1984)<sup>6</sup>. The BCC model will be adopted in the empirical analysis to follow and extends the CCR model presented next. We consider  $m$  inputs (indexed by subscript  $i$ ),  $s$  outputs (indexed by subscript  $r$ ) and  $n$  firms (indexed by subscript  $j$ ). We have inputs

$x_{ij} > 0$  and outputs  $y_{rj} > 0$ . Basically, one is considering the optimisation of a virtual output relative to a virtual input, subject to some constraints. Specifically the following program is solved for each firm:

$$\max_{u,r} h_k = \frac{\sum_{r=1}^s u_r y_{rk}}{\sum_{i=1}^m v_i x_{ik}} \quad (1)$$

$$\frac{\sum_{r=1}^s u_r y_{rj}}{\sum_{i=1}^m v_i x_{ij}} \leq 1 \quad \text{for } j=1,2,\dots,k,\dots,n \quad (2)$$

$$u_r > 0 \text{ (for } r=1,\dots,s) \quad v_i > 0 \text{ (for } i=1,\dots,m) \quad (3)$$

Restriction (2) specifies that no firm can operate beyond the efficiency frontier whereas restriction (3) imposes positive weights. The BCC model extends the CCR model to the variable returns case by introducing an additional restriction pertaining convexity. An important result is that the aggregate efficiency score (obtained from the CCR model) is equal to the technical efficiency score (obtained from the BCC model) multiplied by the scale efficiency score. In the analysis to follow we focus on that pure technical efficiency scores (which do not include

scale effects). DEA procedures allow two different orientations: output augmentation (output orientation-as in the previous program) and input conservation (input orientation). In the first case efficiency refers to obtaining the maximum output for a given level of inputs; whereas in the latter one considers the minimum utilization of inputs for given levels of outputs. In the variable returns to scale case the two definitions need not to be equivalent, though often in empirical applications technical efficiencies in terms of these two different orientations may not differ much. Next, we consider technical efficiency scores as obtained from the BCC model for the input orientation. Such orientation is consistent with the usual interpretation of exogenous outputs (commonly assumed in the context of cost function estimation in regulated industries). These efficiency frontiers were obtained in a yearly basis for the period 1994-97 and all the necessary data was obtained from Telebrás. The following list of inputs and outputs will be considered:

a)Inputs: total number of employees, value (in 10<sup>3</sup> R\$) of switching facilities and total number of access lines;

b)Outputs: number of local calls (pulses), minutes of long-distance (domestic direct dialing-DDD);

The identification of efficiency frontiers for local telephony by means of DEA has been considered before by Majumdar (1995) and Resende (2000). In this type of exercise it is important to consider a parsimonious list of inputs and outputs in order to guarantee a minimum level of discrimination in terms of the relative efficiency scores. In the present case we use somewhat similar inputs to those from the referred papers but in the case of outputs explicit data for interconnection gains was not available. The results are shown next in table 6.<sup>7</sup>

Table 6

Telebrás system-technical efficiency for local telephone companies (variable returns to scale-input orientation)

Local carrier	1994	1995	1996	1997
TELERON	100.0	49.3	46.6	92.3
TELEACRE	77.8	100.0	100.0	100.0
TELAMAZON	100.0	100.0	100.0	100.0
TELAIMA	100.0	100.0	100.0	100.0
TELEPARÁ	100.0	100.0	44.5	100.0
TELEAMAPÁ	100.0	100.0	91.6	100.0
TELMA	91.3	100.0	100.0	100.0
TELEPISA	100.0	100.0	100.0	100.0
TELECEARÁ	38.0	32.4	42.5	52.6
TELERN	85.1	75.2	100.0	100.0
TELPA	100.0	96.4	100.0	100.0
TELPE	23.4	12.5	29.0	52.0
TELASA	58.8	65.0	56.7	66.4
TELERGIPE	100.0	100.0	100.0	100.0
TELEBAHIA	32.0	100.0	100.0	100.0
TELEMIG	100.0	100.0	98.0	80.5
TELEST	69.2	63.3	100.0	29.1
TELERJ	100.0	100.0	100.0	100.0
TELESP	100.0	100.0	41.3	100.0
CTBC	27.6	10.6	15.6	37.9
TELEGOIÁS	45.2	10.7	12.7	100.0
TELEMAT	78.7	74.1	91.6	100.0
TELEMS	100.0	100.0	100.0	100.0
TELEBRASÍLIA	30.3	10.2	100.0	21.4
TELEPAR	100.0	100.0	100.0	100.0
TELESC	17.4	12.7	100.0	100.0
CTMR	76.0	100.0	100.0	100.0
Mean	76.0	74.5	80.4	86.4

The inspection of the table indicates a substantial degree of heterogeneity in Brazilian local telephony with some specific carriers being very distant from the 100% efficient level. Moreover, the path of the efficiency scores over time are erratic in occasions and despite the relative efficiency character of the analysis one can detect firms that underperform in a drastic manner.<sup>8</sup> It is also possible to recognize a reduction of discrepancies from the optimal frontier when we compare

the years of 1994 and 1997. Even though, this represents a relatively short period it is worth investigating whether the efficiency frontier has changed over time. For that purpose, we will consider the Wilcoxon signed-ranks nonparametric test to detect significant changes in the mean efficiency level. The test statistic has the value of  $-2.120$  with a  $p$ -value of  $0.034$  providing therefore evidence on the improvement of efficiency between 1994 and 1997. The firm-level analysis detects, therefore, some improvement in the network over time but also indicates unsatisfactory levels of performance.

### 2.3-The Telebrás System and the Transition to a Privatised System

The previous outline indicated that although the Telebrás system was important in articulating the previously uncoordinated components of Brazilian telecommunications towards network expansion and modernization it had reached an exhaustion as a provision model. Indeed it appears to be a consensus that signs of exhaustion became evident since the 80s [see Almeida and Crossetti (1997), Novaes (1999) and Anatel (2000)]. The most important signs pertained poor service quality and low telephone penetration. A substantial level of unmet demand had become evident as one observed a strong secondary market for fixed telephone lines with prices surpassing at times US\$ 2000 and with official (but severely restricted) provision requiring up to 24 months in waiting lists. The decreasing capacity of the Telebrás system to guarantee an appropriate pace of network expansion and modernization and a prevailing regulatory framework which did not provide incentives for productive efficiency have set the stage for a reform based on the privatisation of Telebrás. In fact, the two major routes for enhancing welfare in the context of utilities refer to the consideration of regulation based on high-powered incentives [for example price-cap regulation] and the introduction of competition. The regulatory framework that had prevailed was based on traditional ROR with strong ministerial intervention and interconnection rules that did not favour efficiency. Moreover, the local monopoly character of the operators did not include any form of competition<sup>9</sup>. The challenge was to conceive a new

institutional model for Brazilian telecommunications which encompassed also a modern regulatory framework. The 1995 constitutional amendment ended the State monopoly in telecommunications whereas the 1996 Minimum Law enabled to privatise the provision of different services most notably the creation of a segment in mobile cellular services (the B-band) that would compete with established firms in the A-band (in the same frequency of 800MHz) to be later privatised in July 1998. The transition to the new model comprised three basic elements:<sup>10</sup> (a) the definition of concession areas in terms of geographic areas and cross-ownership rules; (b) tariff rebalancing; (c) the creation of an independent regulatory agency. The first element will be discussed in a later section of the paper. The importance of tariff rebalancing in different telecommunications privatisations has been emphasized by Ros and Banerjee (2000) who undertook an econometric study for 23 countries and found a negative relationship between unmet demand for telephone lines and tariff rebalancing (after controlling for other relevant explanatory variables). Additionally, cross-subsidies between local and long-distance services are not sustainable in the intended competitive upcoming environment in Brazil<sup>11</sup>. In this sense, tariff rebalancing in November 1995 became an important component in restructuring the sector prior to privatisation. For example, prices in local residential and commercial subscription grew by 512.70 % and 80.54 % respectively whereas long-distance international calls fell by 31.80 %. This movement brought tariffs less distant from international levels and was important in rendering the privatisation process attractive.<sup>12</sup>

Finally, one should point out the importance of the creation of the regulatory agency [Agência Nacional de Telecomunicações-Anatel] by means of the General Telecommunications Law. The basic roles of the newly created agency were to grant licenses and inspect telecommunications service in Brazil. The funding for that agency was defined in terms of a budgetary component and resources accruing from the newly defined Telecommunications Inspection Fund (FISTEL for which the specific regulations would be later approved in 1999). This fund established transfers defined with respect to the revenues of the telephony operators. Finally the agency potentially has access to transitory revenues associated with fines paid by operators that have not achieved universal access and quality targets. In fact, these fines can, at the present

moment, reach a maximum value of US\$ 27 Million in extreme cases. The agency also has the right to audit and promote a comprehensive intervention in the problematic operator in more serious cases.

The institutional design of the newly created agency favoured, in principle, independence. In fact, the new orientation considers recruitment of personnel with known expertise in the area and executive board members have fixed mandates and are nominated by the President of the Republic and must be approved by the Senate.<sup>13</sup> Two important features that increase transparency refer to the need of members of the board to clearly justify their voting decisions and the implementation of a system of public consultation. According to the latter, every new legal instrument in telecommunications must be previously discussed in order to obtain suggestions from different segments of the society.<sup>14</sup> Except for broad political issues, Anatel has autonomy when one considers specific, operational and administrative decisions pertaining telecommunications. Indeed, those decisions can only be reversed by judicial means. Additionally, the agency has the power to forward to the competition agency (CADE) issues on ownership changes of telecommunications operators that might threaten competition and public interest.<sup>15</sup>

The fact that Anatel was created and started operating in November 1997 (before the privatisation process) was important in defining a transition to a regulatory intervention State model, but it is inevitable that learning-by-doing occurs in this new scenario. In a later section we will comment whether the aforementioned desirable properties of Anatel are fully at place.

### 3. BRAZILIAN TELECOMMUNICATIONS: THE NEW SCENARIO

#### 3.1- Overview

The privatisation of the Telebrás system in July 1998 defined the transition to a new configuration in Brazilian telecommunications. A major difference that contrasts with transition processes in other countries refers to the definition in advance of the general regulatory design in terms of the new regulatory agency Anatel. It is worth highlighting the three groups of legal instruments that structures the new sector's profile: (i) the concession plan and the General Telecommunications Norm; ii) universal service targets plan and (iii) service quality targets plan and commitment protocols. Next, we describe these three elements and the reader should also inspect table 7 which presents the main events after privatisation.<sup>16</sup>

The concessions plan defined the geographical scope of concession and deadlines for competition introduction. Four areas were considered for fixed telephony: region I - Northeast, North and Southeast - excluding São Paulo (comprising Alagoas, Bahia, Ceará, Maranhão, Paraíba, Pernambuco, Piauí, Rio Grande do Norte, Sergipe, Amapá, Amazonas, Pará, Roraima, Espírito Santo, Minas Gerais and Rio de Janeiro) region II - South and Mid-West (comprising the states of Paraná, Rio Grande do Sul, Acre, Distrito Federal, Goiás, Mato Grosso, Mato Grosso do Sul, Rondônia, Tocantins) region III - São Paulo; region IV - Brazil

Table 7

Telecommunications Policy: Some Important Events (Post-Privatization Period)

- 1998 : Telebrás auction is held establishing the privatisation of fixed telephony and of the A-band segment of mobile cellular services (in the 29th of July)
- Deadlines for submitting proposals for the auction on mirror companies is postponed due to the lack of interested buyers
- 1999: Auctions relating to mirror companies in the different regions are held with few interested candidates and low premium
- Competition in long-distance service starts with the establishment of the new long-distance dialing code
- Resolution No. 199: approved the general regulations of the Telecommunications Inspection Fund (FISTEL)
- 2000: Law 9998: approved the general regulations concerning the Universal Access Fund (FUST) essentially based on 1 % of the firm gross revenue
- Auctions referring to the baby mirrors are held with few interested buyers
- Anatel announces that operators from A and B bands that do not migrate to future PCS bands (C, D and E) will not be able to renew their concession (September)
- PCS rules are announced and discussed in public consultation
- 2001: C-band starts operating (July), and D and E bands about six months later

Two types telephony operators are defined: the concessionaires that consist of restructured (and privatised) telephone operators and licensed operators that are aimed at introducing competition in the concession areas by means of the so-called mirror companies.<sup>17</sup> Basically, regrouped state operators were privatised in terms of holding companies defined with the referred concession regions.<sup>18</sup> The first three regions refer to regrouping of the original local carriers whereas the fourth region comprising the whole Brazilian territory refers to the scope of action of the long-distance carrier Embratel (as a privatised firm). For each region the incumbent should gradually face the competition of a licensed (mirror) operator. At first, the scenario in fixed exchange services encompassed three holding companies in local telephony and the corresponding (mirror) competitors, and one holding company for

long-distance services in competition with its mirror company.<sup>19</sup> With this model, long-distance calls within the concession area can be operated by the corresponding local operator or by one of the two long-distance operators and calls beyond these limits would require the use of the aforementioned long-distance operators.<sup>20</sup> The introduction of competition in local telephony was facilitated by granting exclusive use of Wireless Local Loop (WLL) to the mirror operators for almost two years since the beginning of their operation. This radio-frequency technology greatly facilitates the entry of competitor by avoiding costly cable deployment. Table 8 summarises the current structure of local telephony and it is worth mentioning that competition in conventional telephony is gradual as the mirror companies are adopting localized expansions within the concession areas.<sup>21</sup>

Table 8  
Fixed Exchange Services in Brazil (as of August 2000)

Concession Region	Regional Holdings	Mirror Companies
I	Tele Norte-Leste Participações S/A (Telemar)	Vésper S/A
II	Brasil Telecom	Global Village Telecom
III	Telesp Participações S/A	Vésper (São Paulo)
IV	Embratel	Intelig
Other operators		
Ribeirão Preto-SP, Guatapará-SP and Bonfim Paulista-SP	Ceterp	
303 localities in Goiás, Mato Grosso do Sul, Minas Gerais and São Paulo	CTBC	Vésper (MG) and Global Village Telecom (GO)
Rio Grande do Sul	CRT	Global Village Telecom
Londrina-PR	Sercomtel	Global Village Telecom

Source: Martinez (1999, 2000), and Dalmazo (2000)



Projected figures from Anatel expect a transition of market shares between concessionaires and licensed operators from respectively 91.94% and 8.06% in December 1999 to 81.72 % and 18.28% in 2005. The most visible competition already appears in terms of the long-distance operators Embratel and Intelig as one can observe intense advertising efforts and discounts policies for long-distance calls. The most rapid transformations, however, took place in the context of mobile cellular service. The institutional design considered in that case involved more concession areas than in conventional telephony. Specifically, the following ten areas were considered: area 1: São Paulo (capital); area 2: São Paulo (remaining of the state); area 3: Espírito Santo and Rio de Janeiro; area 4: Minas Gerais; area 5: Paraná, Santa Catarina; area 6: Rio Grande do Sul; area 7: Acre, Distrito Federal, Goiás, Mato Grosso, Mato Grosso do Sul, Rondônia and Tocantins; area 8: Amazonas, Amapá, Maranhão, Pará and Roraima; area 9: Bahia and Sergipe; area 10: Alagoas, Ceará, Paraíba, Pernambuco, Piauí and Rio Grande do Norte. It is clear that one can contrast more profitable areas (1-6) with less attractive areas in less developed areas (7-10). The structure of mobile cellular services is summarised in table 9

Initially, one is considering a temporary duopoly model for both fixed and mobile services, but the situation is more complex for fixed telephony since the mirror companies did not commit themselves in terms of some very small and some rural localities. For that purpose, bids for the so-called baby mirrors should conduct them to operation in 2001.

Table 9  
Mobile Cellular Services in Brazil (as of August 2000)

Concession Areas	Concessionaires Operators (A-Band)	Licensed Operators (B-Band)
1	Telesp Celular	BCP Telecomunicações
2		Tess S/A
3	Telefônica Celular	Algar Telecom Leste (ATL)
4	Telemig Celular	Maxitel S/A
5	Tele Celular Sul	Global Telecom
6	CRT Celular	Telet
7	Tele Centro-Oeste Celular	Americel
8	Amazônica Celular	Norte Brasil Celular (NBT)
9	Tele Leste Celular	Maxitel S/A
10	Tele Nordeste Celular	BSE
Other Operators same area as related wireline exchange operators	CETERP Celular  CTBC Celular  Sercomtel Celular	

Source: Martinez (1999, 2000) and Dalmazo (2000)

A second foundation for the new configuration of Brazilian telecommunications refers to the general plan on universal access targets that establishes ambitious targets up to the year 2005 (depending on the indicator). For example, towards the end of that year every locality with more than 100 inhabitants will be required to possess a pay phone. By the end of 2004 the maximum allowed time for fixed individual access will be 1 week. These are notable examples of different universal access indicators [see Anatel (2000)]. The challenge is demanding especially in more remote areas and as we shall see satisfaction of those parameters is essential for broadening the scope of operation according with the prevailing rules. Tables 10 and 11 will help in appraising the achievements so far. The former presents the evolution of switched exchange and mobile access, and the corresponding installation charges. The pace of expansion is especially impressive in what concerns the number of cellular lines in service. When one examines, the evolution of installation

charges, these drop dramatically for both fixed and mobile services. For the former, figures are not available on the actual waiting time for installation but the collapse of the related secondary market is a promising indicator. In what concerns the latter, cellular phones are now a common sight in different social classes, with the rapid expansion in part associated with the increasing importance of the pre-paid system.<sup>22</sup> In fact, the still high prices of the service, which can reach in some cases almost US\$ 1 per minute, imply that the service is mostly used to receive calls in the case of lower income users. The favourable evolution in mobile services does not, therefore, eliminate the urgency of granting universal access in fixed telephony.

Table 10  
Telephone penetration and installation charges

	1990	1994	1997	1998	1999	2000 (until July)
Fixed lines installed (10 <sup>3</sup> )	-	13300.00	18800.00	20194.75	27765.87	33338.54
Installation charges (US\$)-fixed telephony			1063.47 (April) 276.52 (May-Oct.) 71.52 (Nov.)	44.36 (Feb.)	6.67 (Since June in Paraná and Brasília)	unchanged
Cellular lines in service (10 <sup>3</sup> )						
A-Band						
B-Band	0.67	755.24	4534.49 15.68	6099.55 1268.66	10756.77 4275.92	13126 5999
Total	0.67	755.24	4550.17	7368.21	15032.69	19125
Installation charges (US\$)-mobile telephony	22000	7500	136	unchanged	32	-
Pay phones (10 <sup>3</sup> )		340.00	589900	710800	739.92	913000

Source: Anatel and Martinez (2000), and author's construct upon R\$/US\$ exchange rates available from Banco Central do Brasil

Table 11 complements the previous table with regional indicators on universal access. One can observe still unmet targets and significant coverage variability across regions. These targets are not very distant from the future proposed targets for these more general indicators. In fact, the most demanding challenges pertain indicators on the coverage of small localities.

Table 11  
Universal Access Targets and Achievements in Switched Exchange Services

Variable/Region	July 1998	Dec. 1999	Jul. 2000	Target until Dec. 2000	Target until Dec. 2001
Fixed lines installed (10 <sup>3</sup> )					
Region I	8253.51	10779.62	13702.35	14468.94	17127.56
Region II	5381.86	7093.91	7645.99	7473.40	8594.01
Region III	6559.38	9892.34	11990.20	10412.24	12250.67
Total	20194.75	27765.87	33338.54	32354.58	37972.23
Pay phones (10 <sup>3</sup> )					
Region I	250.65	355.66	382.19	408.50	490.70
Region II	123.45	162.26	184.16	184.61	219.30
Region III	173.56	222.00	236.31	242.90	271.30
Region IV	-	-	0.05	-	-
Total	547.66	739.92	802.70	836.01	981.30

Source: Anatel

Note: blank figures indicate data unavailability or non-existence of the variable in that occasion

Finally, an important component of the new Brazilian telecommunications sector refers to the service quality targets as established by the PGMQ. The plan defined targets up to the year of 2005 for fixed telephony. Previously, quality targets appeared on the commitment terms associated with the concession contracts. These instruments established monthly firm specific targets for different indicators. In the case of mobile cellular services explicit quality targets will be defined in the context of the forthcoming new generation of wireless telephony arriving in 2001. Meanwhile, one can take as reference information on monthly (firm specific) targets and results as available from commitment terms agreed with the operators. We explore next these different sources. Table 12 displays quality indicators for fixed telephony in terms of the mean value for the indicator in each region and the percentage of operators satisfying the 2000 target. The results are encouraging for the indicators related to network digitalisation, completed calls within 10 sec. and originated (night) completed calls in the different regions. The evidence for the indicators relating to completed (night) long-distance, repair requests and bills with errors is not so positive and the performance can be deemed as insufficient.

Table 12  
Service Quality Targets and Achievements in Fixed Telephony

Variable/Region	July 1998	Dec. 1999	Jul. 2000	Target until Dec. 1999	Target until Dec. 2001
<b>Repair requests per 100 telephone lines (mean value)</b>					
Region I	4.62 (29.41)	2.64 (100.00)	3.65 (83.33)	3.0	2.5
Region II	3.71 (38.46)	3.18 (69.23)	2.25 (84.62)	3.0	2.5
Region III	3.22 (50.00)	2.57 (100.00)	3.72 (75.00)	3.0	2.5
<b>Bills with error complaints per 1000 bills</b>					
Region I	9.16 (0.00)	3.77 (88.24)	4.96 (88.89)	4	3
Region II	13.98 (7.69)	7.56 (38.48)	2.68 (92.31)	4	3
Region III	5.87 (25.00)	3.51 (100.00)	8.13 (60.00)	4	3
Region IV	-	-	12.48 (0.00)	4	3
<b>Originated night completed calls (%)</b>					
Region I	53.12 (11.76)	61.52 (94.12)	61.46 (88.89)	60	65
Region II	61.74 (23.08)	59.90 (46.15)	65.31 (100.00)	60	65
Region III	60.93 (50.00)	60.20 (25.00)	67.78 (100.00)	60	65
<b>Completed night long-distance national calls (%)</b>					
Region I	49.56 (0.00)	58.17 (47.06)	57.65 (35.29)	60	65
Region II	46.65 (0.00)	53.67 (7.69)	55.20 (7.69)	60	65
Region III	54.98 (0.00)	56.51 (50.00)	61.35 (50.00)	60	65
Region IV	47.40 (0.00)	55.40 (0.00)	51.75 (0.00)	60	65
<b>Completed calls up to 10 sec. (%)</b>					
Region I	66.20 (0.00)	83.44 (82.35)	96.62 (100.00)	92	93
Region II	74.84 (7.69)	83.80 (61.54)	97.76 (100.00)	92	93
Region III	63.10 (0.00)	84.05 (25.00)	98.76 (100.00)	92	93
Region IV	94.10 (100.00)	95.77 (100.00)	98.07 (100.00)	92	93
<b>Network digitalization (%)</b>					
Region I	67.55 (47.06)	80.61 (100.00)	87.03 (100.00)	75	85
Region II	71.57 (53.85)	87.49 (84.62)	92.29 (100.00)	75	85
Region III	64.60 (0.00)	86.85 (100.00)	90.69 (100.00)	75	85
Region IV	100.00 (100.00)	100.00 (100.00)	-	75	85
Brazil	67.60 (47.22)	84.59 (91.18)	89.43 (100.00)	75	85

Source: Anatel and author's construct

Note: values are respectively the mean value of the indicator and in parenthesis the percentage of operators satisfying the 2000 target. For originated completed and long-distance calls (third and fourth indicators in the table) there were operators that did not report information and the mean refers to those that had provided the information.

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In table 13, we focus on quality indicators for mobile cellular services. In this case, we make use of the previously referred monthly quality commitment term. The table presents the mean values in each region and the percentage of operators satisfying the monthly (operator specific) target (indicated in parenthesis). A substantial part of the indicators attain the requested targets, though some improvement would be desirable in the indicator referring to the rate of completed calls (PVMC 7).

The general evidence supports an improvement in quality both in fixed and mobile, but further improvements are still required. It is also worth mentioning that no quality indicators for transmission are considered. In fact, it is not uncommon that noise in transmission cause poor Internet connections in different localities in Brazil. In fact, at the time of this writing new results on universal access and quality have just been released by Anatel. In the case of conventional local telephony, Telemar Rio (successor of Telerj after the privatisation) manage to satisfy in August 2000, only 18 of the 35 quality targets. Persistent deficiencies relate for example to repairs done within 8 hours (85.73 % vs. the required 95 %) and rate of completed calls in some categories. Within the holding Telemar (region I), only the state operator Telepisa managed to satisfy all quality targets. The concessionaire Telefônica (region III) also displayed deficient performance in aspects pertaining repairs and congestion. When we consider the overall aggregate performance in Brazil (as of August 2000) it is possible to observe unmet targets for 13 quality indicators and especially persistent deficiencies in indicators relating to repairs, readiness in address change and rate of completed calls for some categories. Even though a thorough analysis will not be feasible, it is clear that quality problems still persist, especially in terms of some particular operators. Anecdotal evidence also shows that some particular operators like Telefônica, and Telemar in Rio de Janeiro) often champion the complaints lists in consumer defence bodies. Table 14 presents (partial) complementary evidence with that respect.

Table 13  
Mobile cellular service - targets and achievements (as of August 2000)

Indicator	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Region 7	Region 8	Region 9	Region 10
PVMC 1	0.89 (100.00)	1.80 (100)	1.33 (100.00)	2.77 (100.00)	1.94 (100.00)	0.79 (100.00)	1.99 (100.00)	3.66 (66.67)	3.94 (100.00)	0.84 (100.00)
PVMC 2	0.70 (100.00)	0.71 (100.00)	9.33 (100.00)	3.82 (100.00)	0.47 (100.00)	0.77 (100.00)	0.88 (100)	4.34 (100.00)	6.61 (100.00)	0.55 (100.00)
PVMC 3	89.36 (100.00)	99.50 (100)	80.14 (66.67)	93.58 (100.00)	89.54 (100.00)	94.67 (100.00)	93.60 (100.00)	90.20 (100.00)	80.45 (100.00)	59.40 (100.00)
PVMC 4	99.86 (100.00)	97.43 (100.00)	99.60 (100)	99.99 (100.00)	97.80 (100.00)	95.77 (100.00)	99.81 (100.00)	95.57 (16.67)	99.92 (100.00)	96.97 (71.43)
PVMC 5	94.70 (100.00)	87.35 (75.00)	76.59 (100)	83.08 (100.00)	71.94 (75.00)	80.53 (66.67)	90.84 (100.00)	84.12 (100.00)	76.59 (100.00)	62.63 (42.86)
PVMC 6	1.81 (100.00)	8.28 (100.00)	6.73 (100.00)	13.29 (100.00)	7.94 (100.00)	3.82 (100.00)	10.40 (100.00)	7.61 (83.33)	8.53 (100.00)	4.71 (100.00)
PVMC 7	58.68 (100.00)	60.16 (75.00)	49.50 (66.67)	58.97 (100.00)	57.60 (75.00)	58.76 (100.00)	57.08 (87.50)	49.30 (16.67)	55.65 (66.67)	52.37 (100.00)
PVMC 8	97.80 (100.00)	95.86 (100.00)	92.97 (100.00)	94.27 (100.00)	96.98 (100.00)	97.81 (100.00)	94.96 (100.00)	92.28 (100.00)	92.67 (100.00)	94.57 (100.00)
PVMC 9	2.16 (100.00)	1.57 (100.00)	2.22 (100.00)	1.60 (100.00)	1.58 (100.00)	1.70 (100.00)	1.47 (100.00)	2.16 (83.33)	1.49 (100.00)	1.61 (100.00)

Source: Anatel and author's construct

Note: values in parenthesis indicate the percentage of operators within a given region that satisfied the target indicators; PVMC 1: complaint rate (%); PVMC 2: coverage and congestion complaints per 1000 mobile accesses; PVMC 3: customer reply rate in terms of customers handled within 10 sec. By operators and attendants (%); PVMC 4: percentage of contacts (information requests, services requests and complaints actually handled within 5 commercial days); PVMC 5: percentage of customers that were present in customer service and were received within 10 min.; PVMC 6: number of complaints on bills with errors per 1000 issued bills; PVMC 7: rate of completed calls (%); PVMC 8: rate of calls' establishment (%); PVMC 9: rate of calls' interruption (%)

Table 14  
Number of Complaints in Brazilian Telephony

	1995	1996	1997	1998	1999	2000
Anatel						until Aug.
Fixed telephony (inc. pay phones)	-	-	-	-	143396	138530
Cellular telephony	-	-	-	-	18634	12801
Consumer defence commission-RJ						until Sep.
Telemar	-	-	-	11125	15496	12612
Vésper	-	-	-	-	-	66
Embratel	-	-	-	-	39	942
Intelig	-	-	-	-	-	15
Telefônica Celular	-	-	-	-	1473	961
ATL	-	-	-	1	855	149
State program for consumer protection						until Sep.
Telemar	396	1193	3029	11125	15701	5610
Vésper	-	-	-	-	-	51
Embratel	-	-	-	-	39	783
Intelig	-	-	-	-	-	8
Telefônica Celular	-	-	-	-	1442	742
ATL	-	-	-	-	373	196

Notes: (i) blank figures reflect data unavailability or date before the creation of the firm; (ii) Data other than those from ANATEL refer to complaints in the city of Rio de Janeiro; (iii) the holding Telemar was created with the privatization in July 1998, therefore one is considering data for Telerj in some cases.

Sources: ANATEL, Consumer Defence Commission-Rio de Janeiro State Deputy House and State Program for Consumer Protection-PROCON-RJ

The first data source (Anatel) provides the general number of complaints received by the call centre from all over Brazil and does not show yet a clear declining trend. The second source refers to the Consumer Defence Commission from the Rio de Janeiro State Deputy House. In principle this source could comprise data from the whole state of Rio de Janeiro but most likely residents in distant localities of the state will not come to Rio de Janeiro to fill a complaint and therefore

the data relates essentially to problems in that city. Again, we cannot verify a sharp decrease in the complaints with respect to Telerj and its successor (Telemar in Rio de Janeiro). A final source of information comes from the State Program for Consumer Protection-PROCON-RJ. This entity, from the judiciary system, has different offices in different states and cities in Brazil, but no consolidated information is available. The reported information had to be restricted to the city of Rio de Janeiro. Once again, we have partial data for the year 2000 and in this case there seems to be some improvement at least with respect to Telemar<sup>23</sup>. In summary, a clear cut decline in the number of complaints is still desirable, with the caveat that information in other traditionally problematic operators is not readily available to allow a more conclusive analysis.<sup>24</sup> Recently Anatel has been challenged on the low quality performance by the congress Deputy House. As a response it has defined in October 18th Investigation Procedure on Unmet Obligations (PADOs). This an important decision since it had previously relied on information provided by the operators and a more proactive approach with stronger intervention was needed. As a complement, the agency intends to carry consumer satisfaction surveys to capture other dimensions not evident in the considered quality indicators.<sup>25</sup>

In the next section we focus on the perspectives of the sector in terms of competition and other relevant items as for example tariffs.

### 3.2- Tariffs, Competition and Other Prospects

#### Competition

The development of competition appears more strongly in terms of long-distance and cellular services. In fact, the recent fierce competition in long-distance service has become evident in terms of strong advertising efforts and implied announced discounts. In the segment of mobile cellular services one can gradually observe some reduction in tariffs.<sup>26</sup> In local telephony the effects of competition are yet to be felt.

The model for fixed telephony established a duopoly at least until 31/12/2001. Within that period each concessionaire in a given concession area would face the competition of a licensed company (the mirror company) and would be able to compete with long-distance operators (Embratel and its mirror company Intelig) within its concession area. This model has worked partially so far. The reader is referred back to table 7 for the relevant events to be discussed in this section. First, there was a large difficulty in attracting bids for mirror companies and even though Vésper has started its operations in 1999, the mirror company in region II, Global Village Telecom is still expected to start operation in 2000.<sup>27</sup> Moreover, since the start the mirror companies were not interested supplying services in some very small and remote localities. For that reason, Anatel conceived the so-called baby mirrors that would fill the referred gap left by the mirror companies in the three regions. Anatel figures indicate that the percentage of population with local operators choice is expected to greatly increase from 2000 to 2001 (predicted figures when the baby mirrors are starting to operate). Specifically one would have: region I (36.59 % vs. 53.26); region II (30.61 % vs. 63.14 %) and region III (52.19 % vs. 86.94 %). The challenge of universal access and competition in a country with continental dimension is obviously not trivial. The competition in the fixed telephony segment will be changing shortly since after 31/12/2001 the market would be open to the entry of new competitors that are willing to comply with the parameters set by Anatel.<sup>28</sup> If the local market is being opened to competition it is important to note that the local fixed telephony concessionaires only will be able to expand their activities to other markets conditional in satisfying universal access targets. If the operators (concessionaires and licensed) manage to anticipate these targets they could be able to compete in other markets after 31/12/2001.<sup>29</sup> For that purpose, one can observe, at this moment, intensive investment effort by those local operators. Some important evidence is provided by the Telecommunications System Expansion and Recovery Plan (PASTE) that sets investment targets. The planned investments for the next 5 years reach US \$ 68.4 billion greatly surpassing the levels established in that plan. Positive expectations on future tariff declines depend also in other factors including the high incidence of state-level value-added tax (ICMS) which rate typically reaches 25 %.<sup>30</sup>

In the context of mobile cellular services, the most important change pertains the bid for concessions under the Personal Communications System (PCS). This technologically superior system would in a few years substitute the established A and B bands (operating in the 800 MHz frequency). The crucial events are, once more, listed in table 7. The first decision was on whether to choose the frequency of 1.9 GHz or 1.8 GHz. As pointed out by Martinez (2000), the former frequency would favour CDMA and TDMA technologies from the United States (currently adopted in Brazil) whereas the latter frequency would favour the European GSM technology. The choice of this second standard seems correct because all the players in the new PCS scenario will start in equal conditions<sup>31</sup> Having defined the technical standard, the bid was organized in term of three bands (C, D and E). The concession areas would coincide with those from fixed telephony and one would consider three operators for each band. As indicated in the aforementioned time-line, the sealed bids considered in the same occasion are to be opened with approximately 60 days between the different bands. The C-band is expected to operate already in July 2001 and the other two bands at least 6 months later.<sup>32</sup> The convergence of the whole cellular segment to the PCS is expected within a few years since the regulator decided not to renew the concession of operators from A and B bands that prefer not to migrate to this new system.<sup>33</sup> Finally, one important new feature arising with PCS is that customers will be able to choose their national and international long-distance operator what does not currently occur.

We can observe, from the previously exposed, that competition in Brazilian telephony is expected to become stronger, especially by 2002. There are some challenges however, as some analysts like Gravina (2000) and Martinez (2000) contend on the large, perhaps, unsustainable number of cellular operators. It is likely that the final configuration of the segment will involve a smaller number of operators. In the American case, for example, the consolidation movement largely reflected the existence of scale economies [see Foreman and Beauvais (1999)].

In summary, the competition prospects seem encouraging. In the case of fixed telephony price declines in local tariffs are

### Tariffs

In the Telebrás system tariffs and interconnection rules followed, as we had seen, criteria that were not conducive to efficiency. Telecommunications services relied on traditional rate-of-return regulation (ROR) with arbitrary ministerial interventions for the purpose of inflation control and interconnection was based on a mutual traffic scheme that benefited operators with weak operational performance. The new scenario under Anatel introduced price-cap regulation for concessionaires in fixed telephony whereas the tariffs in mobile services are deregulated. The cap considered the following productivity factor  $X$  (considering the RPI-X terminology). For local telephony:  $X = 0$  (until 31/12/2000) and  $X = 1\%$  (from 01/01/2001 until 31/12/2005). For national long-distance calls  $X = 2\%$  (until 31/12/2000),  $X = 4\%$  (from 01/01/2001 until 31/12/2003) and  $X = 5\%$  (from 01/01/2004). For long-distance international services  $X = 5\%$  (was in place until 31/12/1999) and  $X = 15\%$  (from 01/01/2000 until 31/12/2000).<sup>34</sup> Productivity factors are important in inducing efficiency by making tariff setting less backward looking and therefore more conducive to productive efficiency. It is important to keep efficiency based regulatory regimes in the future, unless one is absolutely confident that the degree of competition warrants deregulation.

### Interconnection

After privatisation, a transitory system of interconnection charges was established by Anatel. This scheme comprised maximum tariffs for the use of local network, long-distance network and switching which established per minute charges plus additional transitional charges that will slowly decline until reaching a zero value by 30/06/2000. These values vary even within the concession areas, but a typical for the first two aforementioned categories were respectively US\$ 0.022 and US\$ 0.032. Whereas the additional temporary charge initially increased the per minute charge by almost 50% to then gradually decline to zero by the previously mentioned date.

The new interconnection scheme, currently under public consultation, seems to move towards voluntary negotiation between the interested parts (with arbitration of Anatel in case of conflicts). Recently

has emerged a controversy as cellular services providers claim that would have small bargain power in comparison with fixed operators and that they would lose roughly 30% of revenues by that movement. Despite concerns on interconnection relating to cellular services, free negotiation is likely to arrive by 2002.

## 4. FINAL COMMENTS

The discussion of the previous sections indicated that the Brazilian telecommunications can be described in terms of two markedly distinct regimes. Before the privatisation process in July 1998, the system evolved around the State-controlled Telebrás system. Even though this institutional design had merits in structuring the previously chaotic system towards network expansion and modernization, the model would display increasing signs of exhaustion since the 80s given insufficient investment capacity and growing demands. The new model organized around an independent regulatory agency has shown important improvements in terms of network expansion and increasing competition is shortly expected, but the following challenges must be mentioned:

(a) Quality targets: the still unsatisfactory quality levels in fixed telephony have given rise, recently, to a more proactive approach by Anatel as indicated by the introduction of the investigation program PADOs. In fact, more direct auditing and punitive fines are desirable. A better coordination with consumer protection entities is also necessary. Currently, the ombudsman system is not operational and some consumer protection organizations complain of the lack of interaction with Anatel;

(b) Efficiency issues: the regulator is completely betting in the future competition. However, if the sector does not become fully deregulated in the future it is important to monitor efficiency for the purpose of properly establishing price-cap regulation. Also, in the case of cellular services the existence of scale economies can motivate a consolidation trend in the sector. Both points require analysis with detailed plant data. It is worth mentioning that even in the American case where competition



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is increasingly important, the Federal Communications Commission requires detailed accounting and plant data from the operators. A similar attitude would be desirable for the Brazilian regulator

(c) Further competition and network sharing: leaving technical issues aside, cable TV infra-structure and other networks might play an important role in enhancing competition by 2002. Municipal soil usage and issues concerning specific sharing schemes should be addressed. For example, Anatel has already started to focus on regulations of the sharing of electricity network.

(d) Institutional endowments of the sector: the independent character of the Brazilian regulator favours regulatory commitment in contrast with the pre-privatisation scenario.<sup>35</sup> One important difficulty, however, refers to the slow and inefficient judiciary sector in Brazil. For example, Embratel has challenged a high-value fine recently. If such event is representative the actual punitive power of the regulator can be greatly diminished. Moreover, the regulator in order to accomplish a more active inspection and regulatory role will need to invest in human resources. This fact is recognized as major specialised recruitment efforts are predicted for the near future.<sup>36</sup>

Finally, one can say that the configuration of the telecommunications sector in Brazil has drastically changed since privatisation and will experience even more rapid changes in the near future, posing extra responsibilities on the regulator and indicating several research topics related to efficiency, quality and yet scale effects in mobile cellular services, to mention a few.

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## NOTES

1 There were also 4 independent local telephone companies: Companhia Riograndense de Telecomunicações-CRT (owned by the state of Rio Grande do Sul), Centrais Telefônicas de Ribeirão Preto-CETERP (municipal operator in Ribeirão Preto and two other small cities in the state of São Paulo), Serviços de Comunicações de Londrina-SERCOMTEL (municipal operator in Londrina-PR) and Companhia Telefônica do Brasil Central-CTBC (private company operating in different localities in the states of Goiás, Mato Grosso do Sul, Minas Gerais and São Paulo). This last company should not be confused with Companhia Telefônica de Borda do Campo, which is also known as CTBC but was part of the Telebrás system. These independent companies represented a minor part of the Brazilian telecommunications system and were technically integrated with the Telebrás system.

2 A partial reversion was undertaken in 1997 by increasing the sharing factor for some firms that traditionally had weak operational performance like TELERJ. Such local operator had previously benefited from a sharing factor as low as 17.78% whereas that factor reached 30% for some other firms [see Novaes (1999)].

3 In the current section we will occasionally consider tables beyond the privatisation period (July 1998) for presentation purposes, to which we might refer back in a future section.

4 See International Telecommunications Union (1998)

5 Fiuza and Neri (1998) consider also the issue of telephone line possession according to the income level for the years of 1993 and 1995. The results, as expected, indicated worse telephone access for poorer classes;

6 See Charnes et al. (1994) for a comprehensive treatment of DEA

7 All computations were done with the software DEAP version 2.1 by Coelli (1996)

8 Some widely criticized firms such as the local operator from Rio de Janeiro (TELERJ) appear as efficient but a more complete analysis from the point of view of consumer satisfaction would require data on service quality indicators that is not available for that period.

9 One exception included the possibility of bypassing Embratel in international long-distance calls by means of call back schemes.

10 For a more detailed description and the time-line of the privatisation process itself the reader is referred to Novaes (1999) and Martinez (1999).

11 The only legal gap supporting cross-subsidies refers to the case of transitory difficulties in satisfying universal access targets. For some range of parameters typical for developing economies it is possible, within a welfare maximization perspective, justify rural-urban subsidies as a transitory universal access strategy [see Gasmi, Laffont and Sharkey (2000)].

12 Novaes (1998) undertakes more detailed comparisons for different services expressed in US dollars with tariff levels in different countries.

13 This contrasts with the situation that prevailed under the Telebrás system, when even chief executives of the state telephone companies were indicated by politicians. Dalmazo (2000) provides an overview of that phenomenon.

14 Moreover, all newly created instruments must become public. For that purpose Anatel's web site is gradually displaying a series of data and other relevant information (for example a set of the sector's legal pieces). In terms of public relations a 24-hours call center has been established.

15 The initial post-privatisation rule does not allow cross-ownership between different concession areas and across distinct services.

16 Given the scope and space restrictions of the chapter we will not deal with topics relating to data transmission, satellite services, Internet services and TV by subscription to mention a few relevant issues. The reader is referred to Martinez [1999, 2000] and Gravina (2000). The scope of Anatel's operation is also broader than described here including for example setting standards for digital TV, establishing networks to integrate government services in different areas (education, health, security and public management), see Anatel (2000) for an introduction on those issues.

17 The concessions are valid until 31/12/2005 and can be extended once for additional 20 years upon the payment of a bi-annual renewal rate.

18 Important international groups arrived in the Brazilian market, as for example Telefónica de España, Portugal Telecom and MCI among others. For details on

the ownership at different areas and telecommunications services see Martinez [1999, 2000] and Dalmazo (2000).

19 There are also the previously mentioned independent operators, that were privatised when they were public. For example, CRT was a state level privatisation.

20 In the case of the small independent carriers, intra-state long-distance calls should be carried by the long-distance operator (Embratel or Intelig)

21 It is also worth mentioning that were restrictions on cross ownership between local and long-distance operators and different concession areas of local telephony.

22 If we consider firm level information provided by Martinez (2000), we can construct aggregate indicators for the percentage of pre-paid mobile cellular lines (at 31/12/1999) for the 10 regions that are given by: (1 and 2) 36.08%; 3)56.39; 4)32.65%; 5)30.97% 6)44 %; 7)36.54 %; 8)28.95 %; 9)41.56 %; 10)30.59 %

23 Unfortunately data from programs for consumer defence in other states revealed difficult to obtain. It is also not possible to normalize the data in terms of the number of telephone lines since specific information for the city of Rio de Janeiro is not available.

24 Notes in daily newspapers and weekly magazines suggest that the volume of complaints related to Telefônica and the long-distance operator Embratel, in São Paulo at consumer defence bodies like PROCON-SP and IDEC are high. See Beck (2000) and Gigliotti et al. (2000).

25 In fact, at least since September 2000, the agency had announced the hiring of two consulting groups to structure these new monitoring procedures.

26 See Guerreiro (1999) for some pricing information.

27 Vésper is still a localized competitor to the concessionaires, but gradually it is expanding the scope of its activity and the growing advertising effort is emblematic.

28 Potential competitors include cable TV operators. Even though, legal barriers to entry are being eliminated, technical barriers might limit in the short-run the entry of new competitors.

29 Otherwise one would only be able to operate in other markets by satisfying universal access targets, after 31/12/2002.

30 The regulator is also currently investigating the possibility of reducing the number of geographical areas for tariff purposes from 503 to 70. This movement would imply that many calls that are currently classified as long-distance calls would become local calls.

31 Martinez (2000) also mentions the importance of this chosen standard in facilitating the future introduction of the third generation of cellular services represented by

32 Ownership restrictions are as follows: a given group can in principle purchase all three regions in C-band, but then cannot have participation in D and E bands. A given group can purchase the license of different regions of the different bands but not for a same region in different bands.

33 For example, an A-band operator in Rio de Janeiro would expire in seven years.

34 Comparative analyses of price-cap and traditional rate-of-return regulatory regimes appear in Liston (1993) and Resende (1997)

35 See Levy and Spiller (1994) for an outline of institutional features favouring regulatory commitment and a comparative analysis of the telecommunications sector in four different sectors.

36 Human resource development is a transitional problem in many telephony operators, which have been often subcontracting technical personnel without substantial experience to substitute retired technicians as for example in Telemar-Rio. This might explain the low quality performance of some operators and the rapid need for technical formation in telecommunications to match the rapid growth of the sector in Brazil.

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