

ARE FIXED AND CELL PHONES SUBSTITUTES OR COMPLEMENTS?

THE CASE OF BRAZIL

Cristina Lohmann Couri
National School of Statistical Science – ENCE/IBGE

Jorge Saba Arbache
The World Bank, Office of the Chief Economist, Africa Region
University of Brasilia

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Abstract

This paper investigates whether the growth of cell telephony in Brazil after privatization is taking place at the expense of the fixed telephony. We use national household surveys and find that first, despite the rapid growth in cell telephony, complementarity between both types of telephony is still dominant at the household level; second, phone subscription is strongly determined by income, demographic and regional characteristics; and third, cell telephony plays a substitutive role with respect to fixed telephony in rural areas, but a complementary one in urban areas.

Keywords: fixed telephony; cell telephony; substitute; complementary; Brazil.

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Corresponding author: Jorge Saba Arbache, The World Bank, MSN J5-500, 1818 H St NW, Washington, DC, 20433. E-mail: jarbache@worldbank.org.

1. INTRODUCTION

The year 1998 marked the beginning of privatization of telephony services in Brazil. Since then, competition among the new service providers has brought about significant improvements as suggested by the rapid rise of fixed and cell phone subscriptions. In 1997—the year before privatization—there were 17 million residential fixed phone lines in operation; in March 2005 there were 42 million. But the growth in cell telephony was even more impressive, from 4.5 million to 71 million in the same period, thus surpassing the fixed subscriptions in a few years. This phenomenon, also common in other developing countries, raises the question of what impacts the growth of cell telephony has on fixed telephony.

Although one may expect that the greater connectivity and phone network end up stimulating usage of fixed phone lines, it may instead be the case that the growth of cell telephony happens at the expense of fixed telephony. The applied literature on this topic is somewhat controversial, however, and there are findings supporting both hypotheses. Sung, Kim, and Lee (2000) and Rodini, Ward, and Woroch (2002) have found a predominance of substitutability between cell and fixed phone. Hamilton (2003) suggests the existence of different degrees of complementarity of the two services. Hodge (2005) have found both substitutability and complementarity according to households' income and consumption.

This paper uses household microdata to empirically investigate whether the growth of cell telephony in Brazil after privatization is taking place at the expense of the fixed telephony. This case is interesting and can shed light on the experiences of other developing countries: Brazil has recently embarked on a major reform of the telecommunication sector and has experienced a remarkable rise in cell telephony;¹ and Brazil has continental dimensions, one of the highest GDPs, and a modern manufacturing sector, but is still socially underdeveloped with various forms of deprivation and very large regional and household

¹ Brazil is in the sixth place in the world ranking of cell phones.

income inequality.² We find that, first, despite the rapid growth in cell telephony, complementarity between both types of telephony is still dominant at the household level; second, phone subscription is strongly determined by income, demographic and regional characteristics; and third, cell telephony plays a substitutive role with respect to fixed telephony in rural areas, but a complementary one in urban areas. These results have regulatory and market implications.

The paper is organized as follows: Section 2 summarizes the recent changes in the telephony industry in Brazil. Section 3 presents theoretical issues and empirical evidence on complementarity and substitutability between fixed and cell phone subscription. Section 4 discusses the data and the empirical strategy. Section 5 provides the results. Section 6 presents our conclusions.

2. RECENT DEVELOPMENTS IN TELEPHONY SERVICES IN BRAZIL

Over the 1980s and 1990s, the increasing fiscal deterioration restrained the public telecoms monopoly to invest in technological updating and expansion of the network resulting in long waiting lists for telephone lines and worsening of service quality. The precariousness of the telecommunication sector eventually led the government to carry out a major restructuring process which started with a tariff rebalancing in 1995 and culminated with the privatization of the telecommunication industry in 1998, establishment of a regulatory agency (*Agência Nacional de Telecomunicações—Anatel*), and approval of a bill that set targets to be met by the new private-owned companies (*Plano Geral de Metas de Universalização—PGMU*), which aimed at spreading the telephone service all over the

² In 2004, 35.5 per cent of the population was below the poverty line, and the Gini coefficient of personal income was 0.595.

country and among all population by means of public telephones and fixed lines.³ The PGMU did not take into account the role that the cell telephony would later play as an alternative to improve telephony service, especially in the lower income groups.

Table 1 shows the residential fixed and cell phone subscriptions by household income decile. Between 1997 and 2004 the subscription rate increased in all income groups. However, the subscription growth among the poor is noteworthy, suggesting that they benefited the most from the telecommunication sector reform.

(Table 1 here)

Table 2 shows the subscription of fixed and cell phone by household income deciles in 2004. It reveals a dominance of cell over fixed phone subscriptions until the sixth decile. From the seventh decile and on, the situation is inverted with a dominance of fixed line over cell. Even though the total number of cell lines is greater than that of fixed ones, there is a higher concentration of cell phones per household; namely, 2.16 cell phone lines compared to 1.19 fixed phone lines per household.⁴

(Table 2 here)

The introduction of prepaid cell phone is one of the main causes of its popularization in Brazil. Individuals that otherwise would not have access to telecommunication services because of credit history constraints and short supply of fixed lines, for example, were able to make use of cell telephony. As a result, prepaid cell phones now amount to more than 80 per cent of the cell lines in operation. Cost issues are also important due to the low median per capita household income (R\$ 230 in September 2004 or US\$ 79.5). Cell telephony in Brazil is

³ For details of the Brazil's telecommunication sector reform, see Mattos and Coutinho (2005).

⁴ The calculus was based on the following data of September 2003: 25.3 million households with fixed telephone and 24.7 million households with cell telephone; 29.9 million and 58.2 million residential fixed lines and individual cell lines, respectively. Data on the number of phone lines are from Anatel.

associated with high entrance costs in the form of phone and accessories acquisition, but fixed phones have a high subscription cost. Although the price gap between cell and fixed services is decreasing, cell service is still significantly more expensive.⁵ Anecdotal evidence suggests that fixed lines in Brazil are likely to be used at home or in the office, while cell phones tend to be used in almost every other situation. Consumers therefore get more from combining fixed and cell lines based on convenience and telephony cost. That is, consumers may use fixed phone mainly for making calls and cell phone for receiving calls, thus suggesting complementarity between fixed and cell telephony.⁶

The relationship between fixed and cell phones has public policy implications, as most of the bulk of the sector regulation is towards fixed telephone. Yet fixed phone tariffs are regulated while cell telephone tariffs are not. Cell substitution effects have implications toward fixed network unblinding, fixed-cell vertical separation, and universal services. Cell phone providers have no universal service obligations, despite its universal character, especially within low-income groups and population in remote and rural areas. The effect of cell competition on fixed line contributes to lower prices and increase coverage, making a pressure on incumbent firms and leading to improvements in service quality.

3. THEORETICAL AND EMPIRICAL ASPECTS

Cell phones are seen as substitutes for fixed phones to the extent that they do receive and make calls in the same ways as fixed phones do. In addition, they may originate calls under circumstances in which it would be impossible to make use of a fixed phone. According to Mingos (1999), one of the factors that led to the rapid growth of cell telephony is that cell

⁵ Special plans as well as calls that connect cell lines of the same carrier may reduce the cost of cell service or even make it cheaper than the fixed line service. The appendix presents the price structures for fixed and cell telephony in one major state in Brazil.

⁶ In Brazil the caller is responsible for the whole call cost.

infrastructure network can be installed in a much lesser time and cost in comparison to fixed telephony, thus increasing access for the users. Other advantages of the cell telephony pointed out by Minges are the higher functionality such as the potential for roaming, lower tariffs for some services, mobility and portability, service packs, voice and text mailboxes, among other technologies.

Cell phones tend to be dominant in places where the access to fixed telephony is difficult. This is the case of poor and underdeveloped regions and low-density or remote areas, where the cell telephony infrastructure is more cost-effective. As the relative price of cell service falls overtime, usage spreads to other users including lower income groups. When cell phone becomes available in regions where main line access is non-existent or low, it becomes a substitute for main line (Minges, 1999; Hamilton 2003). Consumers who cannot afford or simply do not want to pay monthly subscription fees for a fixed line may substitute it for a prepaid cell phone. This is the case of low-income households and bad credit history people (Hodge, 2005). People can also be attracted by cells not as an access alternative, but because of its social status (Hamilton, 2003).

The complementary character of the cell telephony rests on the idea that even if cell phone subscription is increasing very fast, it does not cause a reduction on the demand for fixed lines. In high-density areas where the average income is high, cell phones are more likely to play a complementary role given that a significant share of the population already has access to fixed telephony. The demand for fixed lines is likely to grow as Internet and other data access needs are increasing. Complementarity arises according to different conceptions of cell phone usage fulfilling the different needs of consumers. In addition, the increase of connectivity and phone network tend per se to increase fixed phone usage.

Empirical studies have presented ambiguous results, which is likely to be a consequence of cell telephony being a relatively recent technology. Right after its

introduction, cell telephony was restricted to few, but the on going fall of service prices has made the diffusion of this technology possible to the majority of people even in developing countries. One may expect that as the costs of the cell telephony go on falling and new services are being attached to cell lines, they will remain an alternative to fixed lines.

Sung, Kim, and Lee (2000) estimate demand equations to modeling substitution between fixed and mobile telephones using a Korean regional panel data for 1991-98. The equation was first estimated for the stock of fixed lines. The results suggest a complementary character between both types of telephony, as mobile telephone connections have a positive correlation with the stock of fixed telephones. To eliminate the effect of previously subscribed persons on the results – as business people and wealthy persons, to whom mobile phones appear as a complementary service – the equation was estimated for new connections and disconnections of fixed phones. An increase in the number of cell telephones resulted in a reduction on new fixed connections and an increase in fixed disconnections. Substitution effects between fixed and cell became predominant. Ahn and Lee (1999) find similar results by estimating the determinants of demand for cell telephone networks for 64 countries. They find that the probability of subscribing to cell is positively correlated with the number of fixed line per person, suggesting complementarity between them.

Based on aggregated annual data of 23 African countries for 1985-97, Hamilton (2003) analyzes the impact of cell subscriptions and institutional variables on the demand and number of fixed lines. The results suggest that cell phones play a complementary role with respect to fixed telephony acting as a competitive force that pushes fixed line operators to improve their service quality. Hamilton concludes that cell telephony can play a complementary or a substitute role at different points in time and at different stages of development of the cell telephony.

Rodini, Ward, and Woroch (2002) examine the substitutability of fixed and cell services using household survey data of the United States for 2000-01. Cross price elasticities show that cell appears as a substitute for fixed line. The likelihood of a household subscribing to cell increases with fixed line access price. For the authors the substitution is due more in respect to a second fixed line: mobile price access resulted in an increase in the likelihood of second line access. Although cell service appears as a substitute for fixed line access; it does not constraint yet local telephony market power. Mobile appears as a moderate substitute for fixed line.

Hodge (2005) calculates a cell-fixed line switching-point based on difference of tariff structures between prepaid cell and fixed lines for households in South Africa and finds that low income households that cannot afford both cell and fixed phones treat cell as a substitute for fixed line, while in higher income households they appear as complements. The switching point is represented by the volume of calls and monthly spend at which average call rates between the two options are equal. Up to this point, consumers who spend relatively little on communication would prefer cell because it offers a lower average call rates. Once consumers spend more they would prefer to take fixed line subscription.

4. DATA AND EMPIRICAL STRATEGY

We use data from the Brazilian household surveys (*Pesquisa Nacional por Amostra de Domicílios* - PNAD) published by the Brazilian Institute of Geography and Statistics (*Instituto Brasileiro de Geografia e Estatística* – IBGE). Each PNAD contains data on roughly 350,000 individuals in about 100,000 randomly selected households following face-to-face interviews. PNAD is the most complete source of information on the characteristics of households and their dwellers, including information on phone subscription. PNAD asks whether there is a fixed and/or cell phone subscription in the household. This is a dummy

variable. A drawback is that there is no information on the number of fixed and cell lines attached to the household and usage. As data on cell phone subscription are available only from 2001 onwards, the investigation starts in this year and ends in 2004, when the last PNAD is available. Despite the limitations, PNAD is the best public accessible database for analyzing the hypothesis of this paper for Brazil.

Our empirical strategy is estimating limited dependent variable models to explain the odds ratio of a household having each type of phone subscription using the other phone type subscription as explanatory variable. Other explanatory variables in the model are the follow: geographical region; rural/urban; utilities available at dwelling; gender and schooling of the head of household; compositional characteristics of family; and per-capita income deciles.

The coefficients quantify the percentage impact of each explanatory variable on the chances of fixed and cell phone subscription using the other phone subscription as explanatory variable. If fixed and cell telephones are indeed substitutes, i.e., if people actually choose between fixed *or* cell telephony, then we might find that a fixed phone subscription reduces the probability of a cell phone subscription and vice-versa. If people choose having both types of services (fixed *and* cell), then we might find that a fixed phone subscription increases the probability of a cell phone subscription and vice-versa.

In order to further investigate the complementarity vs substitutability hypothesis, we estimate independent models for rural and urban dwellings, and for each of the per capita income deciles. We also compare the results of all years to examine trends.

5. RESULTS

Tables 3 and 4 show the model estimates of fixed and cell phone subscriptions, respectively.⁷ The reference categories are households without access to fixed/cell phone subscription; located in the north region; rural zone; no utility services available (no access to sewage, water treatment and garbage disposal service); female head of household and having up to 3 years of schooling, family composed by a couple with no children, and household in first per capita income decile.

The results suggest that cell and fixed telephony are complementary. Yet subscription of a cell phone implies an increase of 26 per cent in the probability of having a fixed phone subscription. The subscription of a fixed phone, in its turn, implies an increase of 24 per cent in the probability of having a cell phone subscription.

The results also suggest a relationship between poverty and access to telephony services. Households with access to utilities as well as those located in richer regions have higher chances to subscribe for a telephone line. There are also positive relationships between the educational level of the head of household and the household per capita income, and phone subscription. For example, a dwelling whose head of household has between four and seven years of education has a probability 33 per cent higher of having a fixed phone subscription and a probability 67 per cent higher of having a cell phone than that of a dwelling whose head of household has less than four years of schooling. If the head of household has 11 or more years of schooling, the probability of having a fixed telephone line is 150 per cent higher than that of a dwelling whose head of household has less than four years of schooling. The probability of subscribing a cell phone, in this situation, is 237 per cent higher.

⁷ Only the results for 2004 are reported. The remaining results are available from the authors upon request.

With respect to household income, families pertaining to the 10th decile of per capita income have a probability 1,483 per cent higher of having a fixed phone subscription, and 922 per cent higher of having a cell phone subscription in comparison to the lowest income families.

Gender of head of household and family composition seems to influence the choice between cell and fixed phones. The probability of a household with a male head of having a telephone subscription is always lower in comparison to a dwelling whose head of household is a woman. This result suggests that men and women while heads of household perceive telephone service in different ways. In regard to family composition, the chances of subscribing a phone line increase in households with children, especially in those where they are less than 14 years old.

Households in urban areas have a probability 166 per cent higher of having a fixed telephone line than those in rural areas. The probability of having a cell phone in this case increases by only 16 per cent.

(Tables 3 and 4 here)

Urban and rural areas

Separate analyses for urban and rural areas show different stories. In urban areas, having a cell phone line in 2004 implied a 29 per cent increase in the probability of having a fixed phone. But in rural areas, a cell phone line implied a reduction of 14 per cent in the probability of having a fixed phone subscription. A similar picture emerges for the impact of fixed on cell subscription. The relationship between fixed and cell phones found in the rural area may be capturing the scarcity of fixed lines in low-density, rural regions, and not necessarily the choice of consumers (see Tables 5-8).

(Tables 5-8 here)

Income

To evaluate the relationship between fixed and cell phones along per capita income groups, we estimate independent models for each income decile. The estimated coefficients of the fixed and cell phone variables in respectively cell and fixed models of 2004 resulted about the same, and are plotted for each income decile in Figure 1. The figure shows a high variance on the degree of complementarity between fixed and cell phone by income decile. Complementarity is very high in the lower deciles, decreases in intermediate income groups, and rises again in the highest deciles.

One explanation for the greater complementarity in low income groups is related to prepaid cell phones, which is dominant among poor people and is being used more as a means of receiving than as one of making calls, and vice-versa for fixed telephones. The low degree of complementarity in intermediate deciles may be explained by the great expansion of the fixed telephony in the post-privatization period, which was focused in its first stages on the medium classes, which was the one long queuing for phone lines. It might be the case that the intermediate income group has preferred in the first instance the fixed service to get connected to the telephone network instead of acquiring cell services, perhaps because of the large differential of cost services. The increase in complementarity in higher deciles might be explained by purchasing power and by the already high access to fixed lines before privatization. Yet telecommunication services such as dial-up Internet and fax among well off households are generally connected to a second fixed line.

(Figure 1 here)

Trends

Figure 2 presents the trends in the degree of complementarity between fixed and cell phones for each income decile. Although there is a common pattern for all years, the estimated coefficients have changed in different ways per income decile. In general, the

degree of complementarity decreased overtime for the first four deciles, although it remained at a high level in the first two deciles. The coefficients of the fifth decile on, except the sixth that did not change, increased over time. This may have occurred because of the rapid diffusion of new telecommunication services among these income groups, and the more efficient use of the fixed and cell phones. The decrease of complementarity along time for the first deciles seems to be associated to the high growth of prepaid cell telephony among these income groups and to the costs of maintaining both types of subscriptions.

(Figure 2 here)

6. CONCLUSIONS

This paper investigated whether the growth of cell telephony in Brazil after privatization is taking place at the expense of the fixed telephony, an issue that has regulatory and market implications. The empirical strategy was assessing the relationship between fixed and cell phone subscription at the household level. Our main result suggests that, despite the rapid growth in cell telephony, complementarity between the two types of telephony is still dominant at the household level.

A second finding suggests that phone subscription is determined by income, demographic and regional characteristics. In regard to income, we found a “U” shaped relationship, meaning that complementarity between fixed and cell phones is higher in the income decile extremes and lower in the intermediate ones, which seems to be capturing the combination of usage of phones according with budget constraints and convenience.

Our third finding suggests that cell telephony plays a substitutive role with respect to fixed telephony in rural areas, but a complementary one in the urban areas, which might be related to supply constraints of fixed telephony in low-density and remote spaces.

To the extent that fixed and cell phones are mainly complementary, socio-economic characteristics determine telephone subscription, and the Brazilian population is mostly urban, then regulatory and universalization policies should consider the issues of price formation, regional peculiarities, as well as the other factors that affect the balance between fixed and cell telephony and the social welfare.

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Appendix

Price structure in Brazil – the case of Rio de Janeiro

Fixed phone subscription makes use of a multipart tariff that includes installation costs, a monthly subscription fee, and rates for calls made. The call prices depend on time of day, network called and the distance of the call. Prepaid cell access is usually based on a two-part tariff subscription with low or no monthly subscription fee and high call rates. Post-paid cell subscription charges a monthly fee and call rates are lower than pre-paid one.

The tables A1 and A2 show the tariff structures for fixed and cell phones in the state of Rio de Janeiro. To simplify the analysis, we compared the rates for local calls at peak times of basic plans. Optional packages as voice mail box services were not considered.

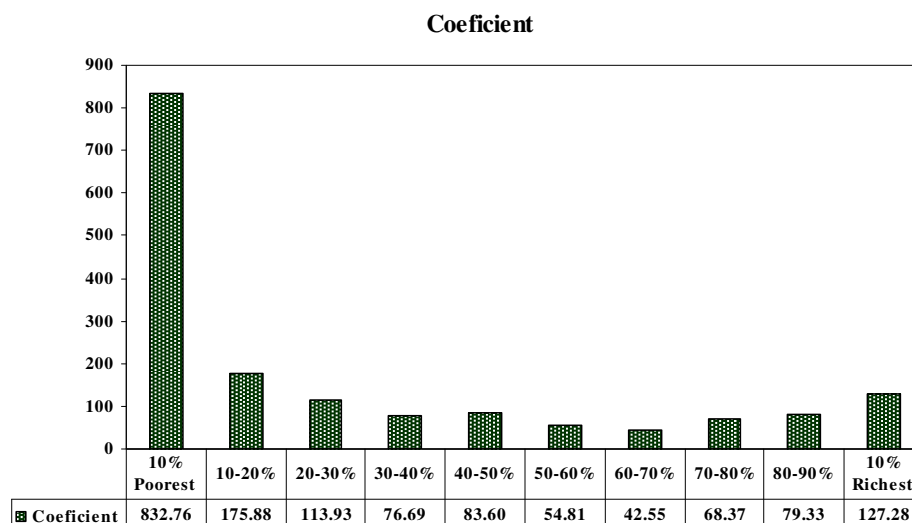
(tables A1 and A2 here)

Some service providers offer plans combining post and prepaid use of the phone: the consumer pays a monthly fixed fee corresponding to the same value on calling with different call rates for different plans (the higher the plan, the lower are the marginal rates). When the value is reached, the consumer can add credits as a prepaid system, with higher marginal rates.

The different costs associated with subscription make relative prices comparisons difficult. For cell subscription, the cost of the phone itself must be considered. Data from the National Expenditure Survey show that the average monthly spending on cell is lower than on fixed telephony in both low and high incomes households. The low income groups spend on average, R\$ 10.76 in fixed telephony and R\$ 2.17 in cell per month. The highest income

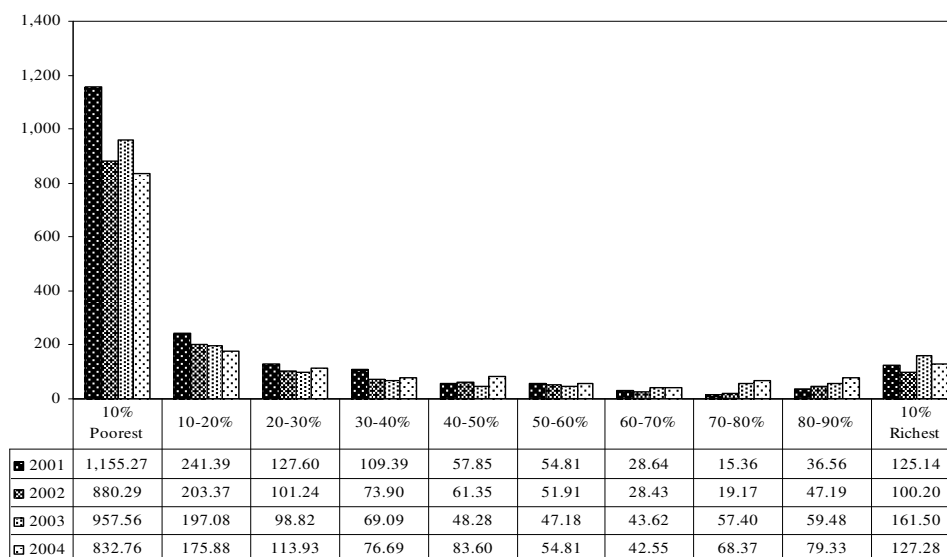
groups' spending is on average R\$ 119.98 in fixed telephony and R\$ 103.58 in cell. The spending with cell and accessories represents about 20 per cent (R\$ 0.43) of total spending on cell telephony for the lowest classes of income, while for the highest, this proportion is about 16 per cent (R\$16.42).

Figure 1: Complementarity and substitutability between cell and fixed phones by per capita household income decile – 2004



Note: the results refer to coefficients of cell phone as explanatory variable in logit models of fixed phone subscription. Models were estimated for each per capita income decile. All coefficients are statistically significant at the 5 per cent level.

Figure 2: Complementarity and substitutability between cell and fixed phones by per capita household income decile – 2001, 2002, 2003, 2004



Note: the results refer to coefficients of cell phone as explanatory variable in logit models of fixed phone subscription. Models were estimated for each per capita income decile. All coefficients are statistically significant at the 5 per cent level.

Table 1: Phone penetration by per capita household income decile – 1992, 1997,

2004

Income Deciles	1992 Fixed	1997 Fixed	2004 Fixed	2004 Fixed and Cell
10% Poorest	0.5%	1.1%	15.0%	25.6%
10-20%	1.9%	3.8%	17.3%	34.0%
20-30%	3.5%	6.1%	25.5%	45.7%
30-40%	6.8%	12.1%	33.7%	55.3%
40-50%	9.0%	18.5%	42.2%	64.8%
50-60%	10.9%	23.8%	51.1%	72.8%
60-70%	18.6%	31.1%	57.5%	76.4%
70-80%	24.0%	39.3%	70.3%	86.8%
80-90%	39.8%	54.2%	80.8%	92.9%
10% Richest	60.4%	73.4%	91.2%	97.7%

Note: cell phone refers to at least one member of household with cell phone subscription. Until 2001 only data for fixed line were available.

Source: Brazilian National Household Surveys – PNAD/IBGE.

Table 2: Phone penetration by per capita household income decile – 2004

Income deciles	Fixed lines Only	Cell lines only	Fixed and cell lines
10% Poorest	6.7%	10.6%	8.3%
10-20%	10.0%	16.7%	7.2%
20-30%	13.7%	20.2%	11.7%
30-40%	17.6%	21.6%	16.1%
40-50%	18.6%	22.6%	23.5%
50-60%	21.4%	21.6%	29.7%
60-70%	22.8%	18.9%	34.8%
70-80%	21.3%	16.5%	49.0%
80-90%	18.0%	12.1%	62.8%
10% Richest	11.2%	6.6%	80.0%

Note: cell phone refers to at least one member of household with cell phone subscription.
Source: Brazilian National Household Survey – PNAD/IBGE.

Table 3: Determinants of fixed phone subscription - 2004

	(b)	Std. Err.	(exp(b)-1)*100
Mobile	0.230	0.019	25.91
Durable	0.729	0.096	107.37
Water treatment	1.024	0.060	178.50
Sewage	0.405	0.023	49.88
Garbage Disposal	1.224	0.051	239.92
CenterEast	0.549	0.048	73.12
Northeast	0.070	0.041	7.24
Southeast	0.700	0.039	101.30
South	0.519	0.042	68.07
Urban	0.978	0.043	165.96
Male head	-0.079	0.041	-7.59
04 to 07 years of schooling	0.285	0.024	32.97
08 to 10 years of schooling	0.497	0.029	64.39
11 or more years of schooling	0.917	0.028	150.11
Couple with children of 14 years or more	0.138	0.029	14.81
Couple with children of less than 14 years	1.081	0.032	194.84
Couple with children of more and less than 14 years	0.834	0.034	130.17
Mother with children of more and less than 14 years	0.195	0.067	21.57
Mother with children of 14 years or more	0.661	0.053	93.61
Mother with children of 14 years or more	-0.311	0.061	-26.72
2 nd Decile	0.009	0.046	0.95
3 rd Decile	0.213	0.045	23.76
4 th Decile	0.421	0.043	52.42
5 th Decile	0.638	0.043	89.21
6 th Decile	0.892	0.043	144.00
7 th Decile	1.175	0.044	223.96
8 th Decile	1.510	0.045	352.88
9 th Decile	1.979	0.048	623.43
10 th Decile	2.762	0.058	1483.55
cons	-6.277	0.127	-99.81

Notes: all coefficients are significant at the 5 per cent level.

Table 4: Determinants of cell phone subscription - 2004

	(b)	Std. Err.	(exp(b)-1)*100
Fixed	0.213	0.019	23.79
Durable	0.521	0.070	68.43
Water treatment	0.656	0.041	92.74
Sewage	0.337	0.022	40.12
Garbage Disposal	0.460	0.039	58.41
CenterEast	0.668	0.044	95.00
Northeast	-0.133	0.036	-12.47
Southeast	-0.043	0.035	-4.23
South	0.426	0.038	53.13
Urban	0.147	0.036	15.85
Male head	-0.169	0.040	-15.54
04 to 07 years of schooling	0.511	0.022	66.63
08 to 10 years of schooling	0.789	0.027	120.20
11 or more years of schooling	1.215	0.026	237.00
Couple with children of 14 years or more	0.431	0.027	53.81
Couple with children of less than 14 years	0.887	0.029	142.85
Couple with children of more and less than 14 years	0.827	0.032	128.65
Mother with children of more and less than 14 years	0.470	0.064	60.06
Mother with children of 14 years or more	0.554	0.050	74.01
Mother with children of 14 years or more	0.012	0.058	1.20
2 nd Decile	0.112	0.040	11.84
3 rd Decile	0.271	0.040	31.10
4 th Decile	0.482	0.039	61.94
5 th Decile	0.653	0.039	92.16
6 th Decile	0.743	0.039	110.17
7 th Decile	0.926	0.040	152.49
8 th Decile	1.225	0.041	240.28
9 th Decile	1.591	0.044	390.87
10 th Decile	2.324	0.052	922.02
cons	-3.744	0.091	-97.63

Note: all coefficients are significant at the 5 per cent level.

Table 5: Determinants of fixed phone line subscription – Urban Area

	(b)	Std. Err.	(exp(b)-1)*100
Mobile	0.252	0.019	28.70
Durable	0.731	0.100	107.71
Water treatment	0.983	0.064	167.35
Sewage	0.353	0.024	42.34
Garbage Disposal	0.768	0.065	115.50
CenterEast	0.592	0.050	80.79
Northeast	0.080	0.042	8.33
Southeast	0.728	0.040	107.01
South	0.576	0.044	77.92
Male head	-0.072	0.042	-6.93
04 to 07 years of schooling	0.282	0.025	32.54
08 to 10 years of schooling	0.494	0.030	63.91
11 or more years of schooling	0.924	0.029	151.94
Couple with children of 14 years or more	0.126	0.029	13.44
Couple with children of less than 14 years	1.115	0.033	204.97
Couple with children of more and less than 14 years	0.829	0.035	129.20
Mother with children of more and less than 14 years	0.191	0.068	21.05
Mother with children of 14 years or more	0.666	0.053	94.57
Mother with children of 14 years or more	-0.311	0.062	-26.70
2 nd Decile	-0.007	0.047	-0.65
3 rd Decile	0.202	0.046	22.37
4 th Decile	0.403	0.044	49.68
5 th Decile	0.622	0.044	86.32
6 th Decile	0.876	0.044	140.12
7 th Decile	1.165	0.045	220.61
8 th Decile	1.490	0.046	343.66
9 th Decile	1.966	0.050	614.39
10 th Decile	2.798	0.061	1541.33
cons	-4.809	0.137	-99.18

Note: all coefficients are significant at the 5 per cent level.

Table 6: Determinants of fixed phone line subscription – Rural Area

	(b)	Std. Err.	(exp(b)-1)*100
Mobile	-0.146	0.081	-13.60
Durable	0.784	0.337	119.05
Water treatment	1.273	0.173	256.98
Sewage	0.980	0.080	166.55
Garbage Disposal	1.457	0.082	329.36
CenterEast	0.242	0.204	27.39
Northeast	0.286	0.166	33.14
Southeast	0.868	0.149	138.10
South	0.341	0.152	40.68
Male head	-0.260	0.253	-22.86
04 to 07 years of schooling	0.409	0.091	50.53
08 to 10 years of schooling	0.610	0.127	84.13
11 or more years of schooling	0.795	0.128	121.38
Couple with children of 14 years or more	0.361	0.120	43.41
Couple with children of less than 14 years	0.811	0.123	125.10
Couple with children of more and less than 14 years	0.944	0.135	156.92
Mother with children of more and less than 14 years	0.332	0.381	39.39
Mother with children of 14 years or more	0.523	0.299	68.67
Mother with children of 14 years or more	-0.130	0.369	-12.21
2 nd Decile	0.419	0.207	52.11
3 rd Decile	0.540	0.210	71.58
4 th Decile	0.921	0.201	151.28
5 th Decile	1.142	0.202	213.23
6 th Decile	1.401	0.201	306.06
7 th Decile	1.670	0.207	431.02
8 th Decile	2.169	0.211	775.35
9 th Decile	2.655	0.221	1322.70
10 th Decile	2.900	0.248	1717.47
cons	-7.197	0.464	-99.93

Note: all coefficients are significant at the 5 per cent level.

Table 7: Determinants of cell phone line subscription – Urban Area

	(b)	Std. Err.	(exp(b)-1)*100
Fixed	0.247	0.019	27.97
Durable	0.395	0.082	48.43
Water treatment	0.513	0.050	67.02
Sewage	0.297	0.023	34.59
Garbage Disposal	0.513	0.055	67.07
CenterEast	0.562	0.048	75.45
Northeast	-0.147	0.039	-13.66
Southeast	-0.103	0.038	-9.83
South	0.286	0.042	33.14
Male head	-0.153	0.040	-14.14
04 to 07 years of schooling	0.513	0.024	67.08
08 to 10 years of schooling	0.798	0.029	122.16
11 or more years of schooling	1.219	0.028	238.31
Couple with children of 14 years or more	0.467	0.028	59.57
Couple with children of less than 14 years	0.938	0.031	155.43
Couple with children of more and less than 14 years	0.876	0.034	140.21
Mother with children of more and less than 14 years	0.531	0.065	70.14
Mother with children of 14 years or more	0.625	0.051	86.77
Mother with children of 14 years or more	0.067	0.059	6.92
2 nd Decile	-0.010	0.043	-1.03
3 rd Decile	0.163	0.043	17.71
4 th Decile	0.372	0.042	45.04
5 th Decile	0.555	0.041	74.23
6 th Decile	0.650	0.042	91.54
7 th Decile	0.840	0.042	131.73
8 th Decile	1.143	0.044	213.55
9 th Decile	1.526	0.047	359.79
10 th Decile	2.284	0.055	881.54
cons	-3.282	0.110	-96.24

Note: all coefficients are significant at the 5 per cent level.

Table 8: Determinants of cell phone line subscription – Rural Area

	(b)	Std. Err.	(exp(b)-1)*100
Fixed	-0.180	0.079	-16.47
Durable	0.644	0.143	90.41
Water treatment	0.571	0.076	77.03
Sewage	0.739	0.061	109.43
Garbage Disposal	0.392	0.061	48.01
CenterEast	1.295	0.116	265.26
Northeast	-0.031	0.100	-3.09
Southeast	0.468	0.098	59.64
South	1.172	0.098	222.69
Male head	-0.414	0.194	-33.92
04 to 07 years of schooling	0.415	0.058	51.48
08 to 10 years of schooling	0.690	0.093	99.36
11 or more years of schooling	1.043	0.100	183.79
Couple with children of 14 years or more	0.212	0.081	23.67
Couple with children of less than 14 years	0.506	0.084	65.85
Couple with children of more and less than 14 years	0.542	0.092	72.01
Mother with children of more and less than 14 years	-0.097	0.282	-9.25
Mother with children of 14 years or more	-0.274	0.231	-23.99
Mother with children of 14 years or more	-0.456	0.275	-36.62
2 nd Decile	0.727	0.107	106.85
3 rd Decile	0.835	0.113	130.53
4 th Decile	1.085	0.112	196.08
5 th Decile	1.223	0.116	239.68
6 th Decile	1.290	0.120	263.45
7 th Decile	1.431	0.127	318.35
8 th Decile	1.699	0.135	446.65
9 th Decile	1.918	0.149	580.44
10 th Decile	2.283	0.188	880.91
cons	-4.193	0.260	-98.49

Note: all coefficients are significant at the 5 per cent level.

Table A1 - Post-paid and pre-paid tariffs from fixed telephony (2006)

Fixed Telephony		
	Post Paid Fixed phone (Livre)	Pre Paid Fixed phone (Livre)
Installation Charge (R\$)	-	-
Fixed Monthly Fee (R\$)	28	21 *
To fixed line phone** (R\$)	0,12	0,14
To mobile phones** (R\$)	0,86	0,86

Source: Livre (2006)

* Minimal monthly charge

** Per minute

Table A2 - Post-paid and pre-paid tariffs from cell telephony (2006)

Mobile Telephony		
	Post Paid mobile phone* (Claro)	Pre Paid Mobile phone (Tim)
Installation Charge (R\$)	-	-
Fixed Monthly Fee (R\$)	39,9	25**
To fixed line phone*** (R\$)	0,75	1,05
To mobile phones same operator*** (R\$)	0,75	1,05
To mobile phones other operators*** (R\$)	0,88	1,05

Source: Claro (2006) and Tim(2006)

* 40 minutes usage included

** Minimal monthly charge

***Per minute