

Broadband expansion in Brazil: An empirical study

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BIOGRAPHIES

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ABSTRACT

In this study we carry out empirical analyses to try and identify key drivers of broadband expansion. After a comparative study of broadband markets in Brazil and other countries, we use OECD data to estimate the relationship between broadband penetration and GDP per capita, urban population, ownership of personal computers and number of cable TV subscribers per 100 inhabitants. The last variable measures the impact of competition between DSL and cable networks on broadband penetration, and its positive coefficient is evidence that facilities-based competition fosters broadband expansion. We run a second batch of estimations to generate simulations of future broadband penetration rates and prices by geographic regions of Brazil. Our main conclusions are the following: There is evidence that broadband markets in Brazil lack the necessary network competition; public policies in Brazil should put a premium on curbing anti-competitive practices and fostering the deployment of alternative (to DSL) broadband networks.

Keywords

Broadband, penetration rates, facilities competition.

INTRODUCTION

Broadband has the potential to become one of the key drivers of productivity gains and economic development in Brazil and around the world (Holt and Jamison, 2009; Koutroumpis, 2009). But how can the expansion of broadband networks and services be properly encouraged in Brazil? In order to answer that question, this paper first carries out a comparative study of high-speed networks and broadband markets in Brazil and other countries. Our goal is to make an assessment of the recent evolution of broadband in Brazil in terms of penetration rates, prices, speed, connection type and other indicators.

Given that assessment, our next step is to identify the main factors behind the varying rates of deployment of high-speed networks and services observed across different economies. Using OECD data and panel data methods, we estimate the relationship between the number of broadband users per 100 inhabitants and variables such as GDP per capita, urban population and ownership of personal computers. Another important explanatory variable present in the model is the number of cable TV subscribers per 100 inhabitants. Its inclusion is an attempt to measure the impact of competition between DSL and cable networks on broadband penetration rates. This should shed some light on the debate over facilities-based competition versus service-based competition (open access public networks).

We use some of the results from the first batch of estimations to generate simulations of future broadband penetration rates and prices by geographic regions of Brazil. These simulations are preceded by a new set of regressions that estimate demand schedules (relationship between prices and broadband penetration) using data available from Brazilian sources on the willingness of Brazilian consumers to pay for internet services.

The paper is structured as follows. In section 2 we provide a brief comparison of some key broadband indicators available for Brazil and other countries. Most of our comparisons involve OECD countries, due to the abundance of broadband data available for them. Section 3 presents our econometric estimations of the key drivers of broadband penetration, whereas section 4 contains the results of our simulations of future broadband penetration rates and prices. The last section concludes.

BROADBAND IN BRAZIL

In this section, we compare some broadband indicators for Brazil to those available for other countries, especially OECD countries. The main goals are to determine the current stage of development of the Brazilian broadband market and to identify possible drivers of the expansion of broadband networks and services.

Penetration

We first present the recent evolution of broadband in Brazil and break it down by geographic region.

Region	2001	2002	2003	2004	2005	2006	Jun-07	Sep-07	Mar-08	Jun-08	Dec-08	Jun-09
Southeast	--	--	--	--	--	--	4.2	4.6	5.2	5.8	6.24	6.01
Northeast	--	--	--	--	--	--	0.7	0.7	0.9	1.0	1.09	1.19
South	--	--	--	--	--	--	4.5	4.9	5.5	5.9	6.61	7.49
North	--	--	--	--	--	--	2.00	2.1	2.4	2.7	2.96	3.51
Midwest	--	--	--	--	--	--	3.9	3.9	4.4	4.7	5.49	6.05
Brazil	0.2	0.4	0.7	1.3	2.2	3.0	3.4	3.8	4.25	4.6	5.16	5.8

Source: Barômetro Cisco de Banda Larga 2005-2010

Table 1: Broadband penetration (connections per 100 inhabitants): Brazil and geographic regions

Notice initially the great discrepancy by region. Broadband penetration rates in the North and Northeast are well below those observed in other regions. On the other hand, overall growth rates in the North and Northeast regions were the largest in the period considered (of course their base penetration rates were very small), as can be seen in the table below.

Region	2008	2009	Overall
Southeast	38.10	3.62	43.10
Northeast	42.86	19.00	70.00
South	31.11	26.95	66.44
North	35.00	30.00	75.50
Midwest	20.51	28.72	55.13
Brazil	35.29	26.09	70.59

Source: Barômetro Cisco de Banda Larga 2005-2010; calculations by author.

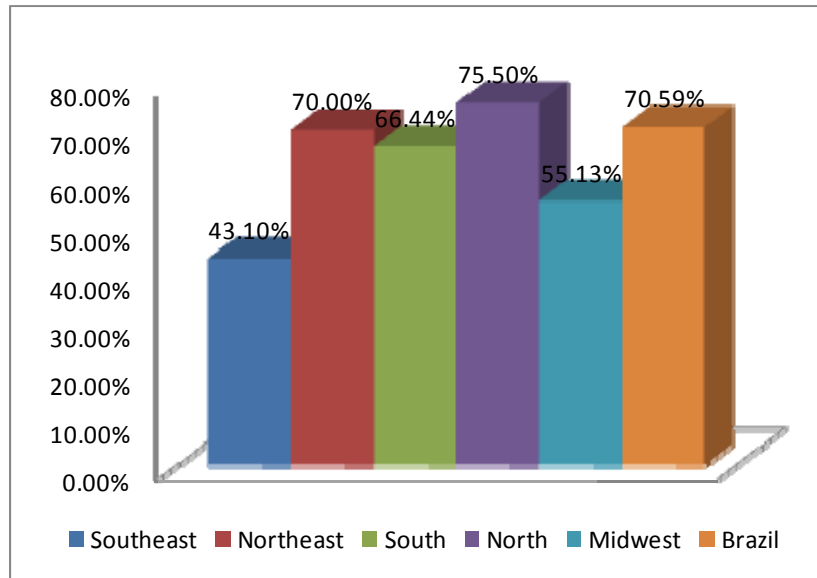
Table 2: Growth rates of broadband penetration¹: Brazil and geographic regions

The smallest overall growth rate, of around 43%, was found in the Southeast. For the country as a whole, the overall growth rate of broadband penetration was around 71%. It is important to notice as well the apparent deceleration of the broadband

¹ The growth rate for year t , where t can be 2008 or 2009, was calculated as $(\text{penetration June of year } t - \text{penetration June of year } t-1) / \text{penetration June of year } t-1$. The overall growth rate was calculated as $(\text{penetration June of year 2009} - \text{penetration June of year 2007}) / \text{penetration June of year 2007}$.

penetration in all regions but the Midwest when 2009 is compared to 2008. There is not enough data to tell if that is the beginning of a trend, though.

The overall growth rates by region are shown in the figure below.



Source: Barômetro Cisco de Banda Larga 2005-2010.

Figure 1: Overall growth rates of broadband penetration: Brazil and geographic regions

It is important to put the figures for Brazil in perspective by comparing them to those observed in other countries. The table below shows the evolution of broadband penetration in OECD countries².

² Notice that broadband penetration in Brazil is measured in connections per 100 inhabitants, whereas in the OCDE it is measured as subscribers per 100 inhabitants. These indicators are practically equivalent.

Country	Jun-02	Dec-02	Jun-03	Dec-03	Jun-04	Dec-04	Jun-05	Dec-05	Jun-06	Dec-06	Jun-07	Dec-07	Jun-08	Dec-08	Jun-09
Australia	1.31	1.84	2.58	3.49	5.19	7.66	10.66	13.60	16.90	18.33	22.21	22.83	23.16	24.80	24.90
Austria	4.57	5.61	6.48	7.64	8.65	10.61	12.40	14.35	15.70	16.71	18.64	19.29	20.16	21.22	21.84
Belgium	6.24	8.67	10.23	11.70	14.18	15.54	17.35	18.17	19.21	22.34	23.82	25.75	26.05	27.67	28.40
Canada	10.25	12.11	13.15	15.06	16.40	17.61	18.97	20.73	21.88	24.29	24.68	27.20	27.04	28.19	29.72
Czech Republic	0.12	0.17	0.28	0.48	0.75	2.50	4.12	6.46	9.59	11.07	12.16	14.58	15.59	16.97	18.14
Denmark	6.64	8.25	11.05	13.10	16.90	18.96	21.71	24.92	29.25	31.79	34.33	35.79	36.35	36.81	36.98
Finland	3.49	5.45	5.34	9.48	10.93	14.92	18.66	22.39	24.87	27.14	28.84	30.71	30.42	30.43	29.73
France	1.57	2.76	3.97	5.94	7.87	10.46	12.63	15.07	17.57	20.13	22.40	24.61	26.04	27.64	29.12
Germany	3.20	3.95	4.83	5.59	6.56	8.37	10.24	12.98	15.11	18.19	21.21	23.71	26.33	27.44	29.28
Greece	0.00	0.02	0.02	0.10	0.23	0.47	0.84	1.41	2.70	4.57	7.08	9.74	11.09	13.41	16.98
Hungary	0.43	0.65	1.15	1.99	2.52	3.57	4.68	6.34	9.73	9.59	11.62	13.86	15.77	16.90	16.82
Iceland	5.29	8.45	10.82	14.26	15.19	18.20	21.48	26.37	26.51	28.83	29.78	32.18	30.80	32.47	32.75
Ireland	0.05	0.27	0.39	0.83	1.61	3.32	4.23	6.61	8.81	12.20	15.05	17.62	18.74	20.17	21.38
Italy	1.19	1.68	2.80	4.13	6.02	8.08	9.70	11.77	13.06	14.24	15.81	17.21	17.91	18.84	19.83
Japan	4.00	6.22	8.79	10.90	13.16	14.96	16.71	18.15	19.18	20.69	21.26	22.51	22.98	23.58	24.22
Korea	22.11	24.31	25.07	26.12	26.24	27.03	28.26	28.69	27.63	29.01	29.90	30.46	30.98	31.84	32.79
Luxembourg	0.61	1.54	2.27	3.46	5.57	9.64	11.38	14.48	17.20	21.01	21.95	27.35	27.37	29.42	31.35
Mexico	0.16	0.25	0.31	0.42	0.74	1.01	1.67	2.22	2.82	2.84	3.49	4.30	5.07	7.14	8.41
Netherlands	4.93	7.04	9.07	11.79	15.43	18.96	22.32	25.22	28.80	31.00	33.47	34.38	35.32	35.61	38.09
New Zealand	1.09	1.61	2.08	2.57	3.48	4.72	6.96	9.12	11.56	11.83	16.34	18.10	19.81	21.25	22.78
Norway	2.99	4.20	6.15	8.18	11.56	15.20	18.57	22.62	25.54	26.84	30.32	30.81	32.61	33.72	34.51
Poland	0.15	0.30	0.45	0.78	1.19	2.14	2.19	2.41	5.33	7.18	7.98	8.65	9.58	10.48	11.30
Portugal	1.48	2.51	3.54	4.81	6.27	7.89	9.71	11.05	12.28	13.45	14.28	14.30	14.76	15.93	17.03
Slovak Republic	0.01	0.01	0.01	0.35	0.62	0.96	1.61	2.49	4.02	5.08	6.83	7.66	8.89	11.45	12.59
Spain	2.07	2.98	4.18	5.41	6.46	8.06	9.10	11.51	13.31	15.11	16.98	17.92	19.03	20.08	20.79
Sweden	6.67	8.16	9.47	11.15	12.44	14.88	17.54	20.78	23.57	26.41	28.69	30.61	30.59	31.51	31.62
Switzerland	3.83	5.64	9.17	10.55	14.60	17.67	20.25	23.85	26.59	27.67	30.90	32.26	32.06	32.73	33.77
Turkey	0.02	0.04	0.06	0.28	0.29	0.71	1.20	2.12	2.92	3.80	5.10	5.95	7.05	8.07	8.71
United Kingdom	1.27	2.32	3.67	5.39	7.36	10.36	13.25	16.32	19.18	21.45	23.73	25.78	27.24	28.16	28.92
United States	5.53	6.71	7.94	9.57	10.91	12.76	14.22	16.32	18.16	20.27	21.87	23.44	24.51	25.43	26.65
OECD	3.80	4.81	5.88	7.14	8.35	9.91	11.29	12.96	14.56	17.01	18.56	20.02	21.07	22.16	22.79

Source: OECD.

Table 3: Broadband penetration (subscribers per 100 inhabitants): OECD

The next table brings the corresponding growth rates.

Country	2002	2003	2004	2005	2006	2007	2008	2009
Australia	53.74%	97.77%	100.68%	105.62%	58.48%	31.43%	4.24%	7.51%
Austria	27.00%	41.78%	33.44%	43.37%	26.64%	18.73%	8.19%	8.34%
Belgium	43.23%	63.82%	38.67%	22.34%	10.71%	24.03%	9.36%	9.02%
Canada	15.61%	28.28%	24.73%	15.68%	15.34%	12.80%	9.58%	9.92%
Czech Republic	0.19%	135.87%	168.62%	448.89%	132.66%	26.73%	28.22%	16.36%
Denmark	49.77%	66.33%	52.97%	28.48%	34.73%	17.34%	5.90%	1.73%
Finland	166.24%	53.09%	104.54%	70.74%	33.31%	15.96%	5.47%	-2.26%
France	50.83%	152.33%	98.26%	60.45%	39.11%	27.47%	16.28%	11.83%
Germany	38.55%	50.87%	35.97%	56.03%	47.53%	40.40%	24.10%	11.22%
Greece	0.00%	2668.73%	1179.09%	260.79%	221.00%	162.53%	56.61%	53.13%
Hungary	69.44%	164.63%	119.82%	85.41%	108.03%	19.41%	35.72%	6.65%
Iceland	43.80%	104.75%	40.39%	41.37%	23.40%	12.33%	3.43%	6.35%
Ireland	392.12%	671.24%	307.53%	163.03%	108.36%	70.78%	24.49%	14.11%
Italy	64.08%	136.16%	114.54%	61.20%	34.67%	21.07%	13.29%	10.72%
Japan	79.51%	119.63%	49.60%	26.98%	14.80%	10.84%	8.10%	5.40%
Korea	19.77%	13.36%	4.65%	7.70%	-2.21%	8.22%	3.61%	5.84%
Luxembourg	117.20%	275.36%	145.27%	104.20%	51.23%	27.59%	24.70%	14.53%
Mexico	44.16%	90.63%	140.18%	127.80%	68.21%	23.85%	45.40%	65.73%
Netherlands	29.32%	83.79%	70.20%	44.64%	29.01%	16.24%	5.51%	7.85%
New Zealand	51.18%	89.79%	67.58%	99.88%	66.27%	41.29%	21.26%	14.96%
Norway	60.15%	105.98%	87.82%	60.70%	37.52%	18.71%	7.58%	5.83%
Poland	172.20%	189.91%	165.72%	84.46%	142.98%	49.62%	20.11%	17.98%
Portugal	53.05%	139.86%	77.19%	54.89%	26.48%	16.25%	3.41%	15.37%
Slovak Republic	0.00%	-0.01%	7850.39%	160.06%	149.10%	69.85%	30.11%	41.63%
Spain	78.10%	101.74%	54.47%	40.78%	46.23%	27.62%	12.08%	9.21%
Sweden	28.06%	42.05%	31.38%	40.98%	34.38%	21.73%	6.61%	3.37%
Switzerland	95.17%	139.58%	59.21%	38.71%	31.32%	16.22%	3.75%	5.33%
Turkey	36.37%	180.31%	391.17%	306.85%	143.62%	74.84%	38.29%	23.45%
United Kingdom	115.09%	187.98%	100.68%	80.03%	44.78%	23.67%	14.80%	6.18%
United States	27.28%	43.63%	37.44%	30.36%	27.69%	20.41%	12.06%	8.76%
OECD	29.60%	54.72%	42.02%	35.34%	28.88%	27.52%	13.51%	8.15%

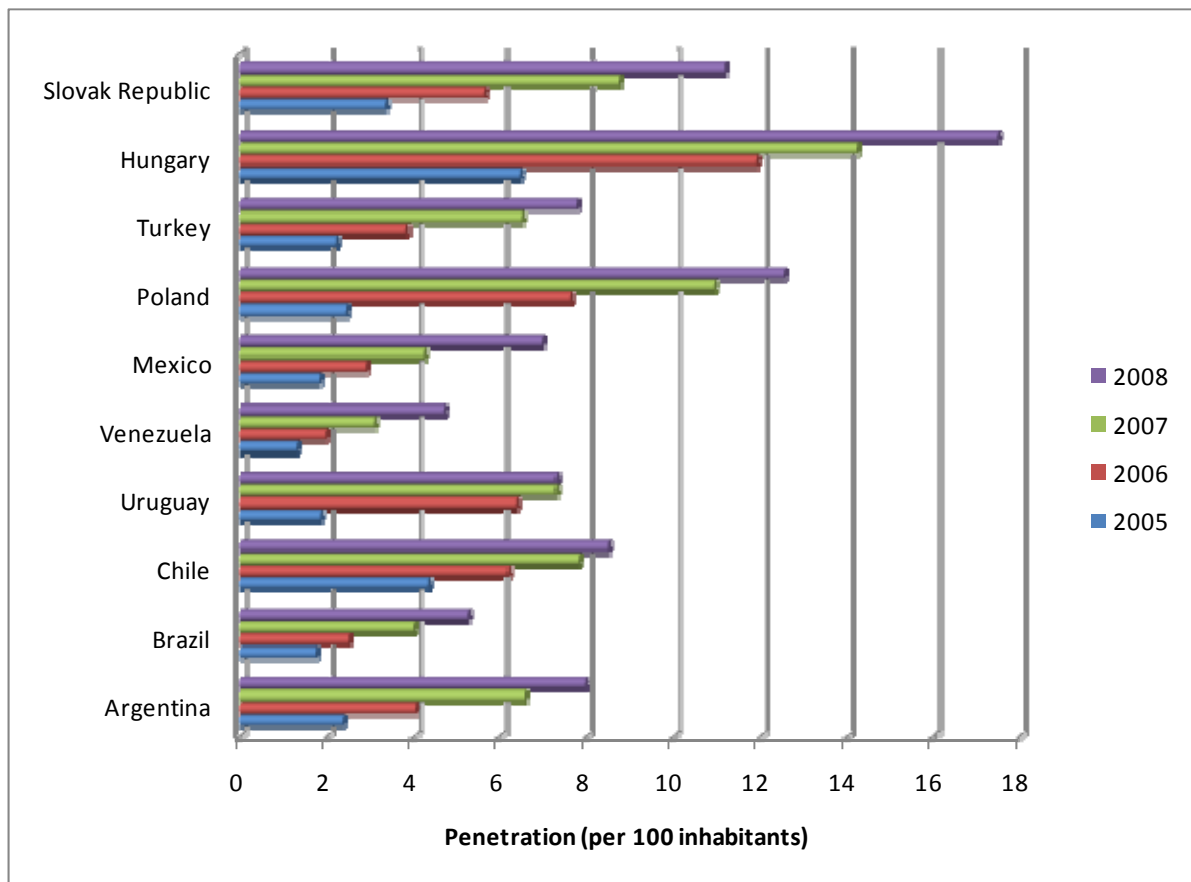
Source: OECD; calculations by author.

Table 4: Growth rates of broadband penetration: OECD

A first observation is that broadband penetration in Brazil by mid-2009 was approximately the same as the average in the OECD by mid-2003. Second, recent growth rates for Brazil as a whole are comparable to average growth rates in the OECD for 2005 and 2006. If this is any indication of how broadband penetration in Brazil will evolve, it is worrisome, for the penetration rate in the OECD was 11.29 per 100 inhabitants in June of 2005, whereas that in Brazil was only 4.6 per 100 inhabitants in June of 2008. Another way to see this is to compare the Brazilian broadband penetration growth rates in 2008

and 2009 to the average OECD rates in 2003 and 2004, when the penetration rates were similar. The Brazilian growth rates were 35.29% and 26.09%, respectively, whereas the average OECD rates were much higher, 54.72% and 42.02%, respectively. A direct comparison between broadband penetration rates in Brazil and OECD countries is evidently imperfect and subject to many caveats, but two can be drawn: (i) the size of the Brazilian broadband market is considerably smaller than that of developed economies; (ii) there is a great potential for broadband in Brazil.

Another interesting comparison of broadband penetration rates can be made between Brazil and countries with similar income per capita. Since some of the countries included in the figure below are not part of the OECD, we use data from the International Telecommunication Union – ITU (including OECD countries, for the sake of consistency).



Source: International Telecommunication Union – ITU.

Figure 2: Broadband penetration (connections per 100 inhabitants): Upper middle income countries³

It can be easily seen that Brazil’s position in terms of broadband penetration when compared to other upper middle income countries is not very favorable either. As a matter of fact, only Venezuela has a lower penetration rate in any of the years from 2005 to 2008. This adds to the evidence that the Brazilian broadband market is not developing fast enough.

³ We used the last World Bank list (July of 2009) of countries classified as upper middle income. Hungary and the Slovak Republic show up on this list as high income countries, but we included them in this comparison because they were considered upper middle income countries in classifications prior to 2008.

Speed

We will now compare broadband speeds in Brazil and other countries. The table below shows the average speed in Kbps in OECD countries.

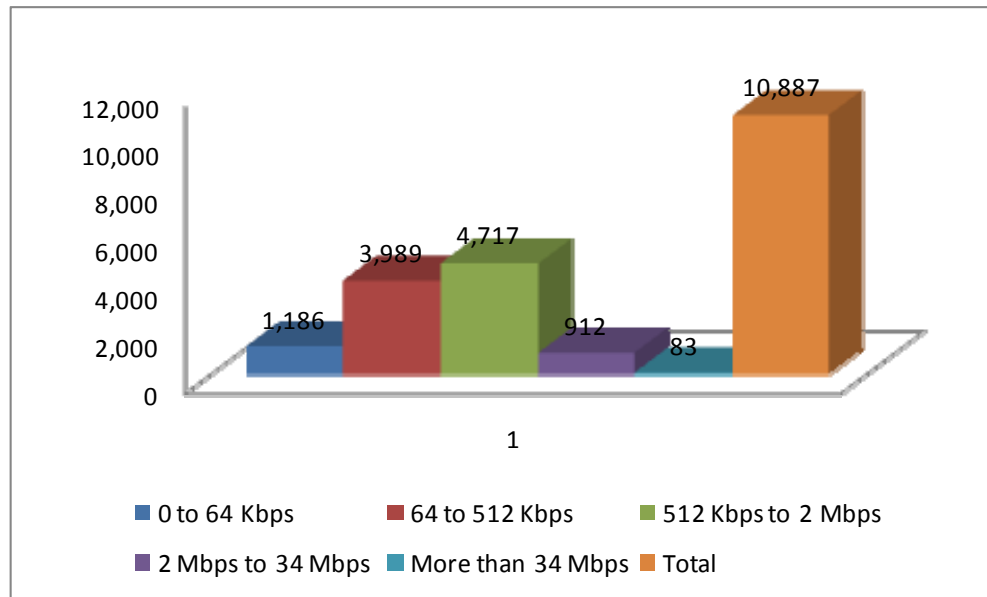
Country	Average advertised broadband download speed (Kbps)	Country	Average advertised broadband download speed (Kbps)
Australia	21,823	Luxembourg	10,457
Austria	25,519	Mexico	2,514
Belgium	10,825	Netherlands	33,679
Canada	19,567	New Zealand	17,807
Czech Republic	18,788	Norway	18,000
Denmark	20,397	Poland	19,675
Finland	18,384	Portugal	103,718
France	54,551	Slovak Republic	26,939
Germany	16,033	Spain	12,800
Greece	15,945	Sweden	23,693
Hungary	27,542	Switzerland	20,073
Iceland	17,774	Turkey	10,473
Ireland	6,088	United Kingdom	19,681
Italy	14,336	United States	14,619
Japan	107,725	OECD	30,550
Korea	52,772		

Source: OECD

Note: Advertised speeds are the theoretical maximum for the employed technologies. Users commonly have lower actual speeds. Moreover, typically only parts of the country have been upgraded to the fastest speeds.

Table 5: Average advertised broadband download speed (Kbps) (all fixed technologies) – October 2009

We were not able to find immediately comparable data for Brazil, but the information given in the table below about the distribution of broadband connections by speed can be used to calculate a similar indicator.



Source: Telebrasil – O Desempenho do Setor de Telecomunicações no Brasil: Séries Temporais.

Figure 3: Fixed connections in service by transmission speed – 2008

The average speed of broadband connections in Brazil computed under the assumption that average speed is equal to top speed for each interval⁴, a methodology that clearly leads to overestimation, is approximately 4,671 Kbps. This is considerably below the OECD average and even below the average speed in countries with similar levels of income per capita as Brazil, like Turkey, Poland, the Slovak Republic and Hungary⁵. If speed connection is to be taken as a measure of quality of broadband services, it is evident that broadband in Brazil is of relatively poor quality.

Prices

Another important variable to study when comparing broadband in Brazil with that in other countries is price. The figure below presents average prices of a basket of fixed broadband services calculated by the International Telecommunication Union - ITU. The fixed broadband Internet basket is calculated based on the price of the monthly subscription to an entry-level fixed broadband plan. It is in fact a sub-basket of an ICT (Information and Communication Technology) price basket calculated by the ITU. The other two sub-baskets are fixed telephone and mobile cellular.

⁴ We use 100 Mbps as the top speed of the last interval, which is a little less than the maximum average speed reported by OECD countries (Japan). This adds to the overestimation effect mentioned in the text.

⁵ It is likely that the average speed of broadband in Brazil has increased between 2008 and October of 2009, the month when the OECD data were collected.

Rank	Country	Broadband sub-basket (US\$)		Broadband sub-basket (PPP\$)		Rank	Country	Broadband sub-basket (US\$)		Broadband sub-basket (PPP\$)	
		2008	2009	2008	2009			2008	2009	2008	2009
1	Israel	-	6.7	-	7.0	42	Finland	38.0	39.0	25.2	27.3
2	Sri Lanka	21.0	4.4	53.4	10.4	43	Mexico	37.0	16.2	53.6	27.6
3	Costa Rica	17.0	6.3	31.6	11.9	44	Austria	60.9	36.1	46.0	27.9
4	Romania	22.7	7.2	27.9	12.4	45	Turkey	-	18.2	-	28.2
5	Maldives	9.4	9.4	14.6	12.7	46	Bulgaria	15.6	14.8	30.6	28.3
6	Macao, China	10.0	8.9	14.8	13.1	47	Bhutan	60.7	10.0	161.6	28.5
7	India	6.1	5.2	16.4	15.6	48	Netherlands	38.1	36.2	28.2	28.6
8	Denmark	30.4	29.1	17.4	17.2	49	Kazakhstan	-	17.2	-	28.8
9	Trinidad & Tobago	12.7	12.6	19.6	17.4	50	Japan	31.6	37.5	28.0	29.0
10	Hong Kong, China	25.4	12.8	36.0	18.1	51	Latvia	26.0	24.9	34.0	29.1
11	Mongolia	-	8.5	-	18.4	52	Portugal	30.2	29.0	28.4	29.6
12	Belarus	-	7.2	-	18.4	53	Luxembourg	44.3	42.0	31.4	30.0
13	United States	15.0	20.0	15.0	20.0	54	TFYR Macedonia	14.7	14.2	30.2	30.2
14	Australia	27.5	26.0	21.0	20.2	55	Mauritius	50.6	16.6	88.2	30.8
15	Lithuania	15.9	15.2	22.2	20.4	56	Panama	15.0	16.6	28.8	31.2
16	Poland	27.0	13.7	31.0	20.6	57	China	18.5	17.6	36.8	31.5
17	Switzerland	32.2	32.7	20.6	20.9	58	Bosnia and Herzegovina	14.8	18.5	24.7	32.1
18	Ukraine	20.8	7.2	45.2	21.2	59	Norway	57.0	51.0	33.5	32.7
19	Belgium	30.5	29.0	22.3	21.7	60	Iceland	57.0	33.5	38.7	33.3
20	Canada	19.8	24.8	16.5	22.0	61	Estonia	38.5	27.8	46.3	33.4
21	Singapore	21.9	16.7	29.0	22.0	62	Saudi Arabia	39.7	26.7	57.7	33.6
22	Egypt	8.3	8.2	24.9	22.2	63	Brazil	47.3	28.0	56.5	34.1
23	Greece	25.2	23.9	23.2	22.4	64	Malaysia	20.5	19.0	37.7	34.2
24	Russia	13.9	13.3	21.1	22.4	65	Slovak Republic	28.5	28.6	35.0	34.9
25	Slovenia	27.5	21.7	27.8	22.8	66	Germany	38.1	43.4	28.2	35.1
26	United Kingdom	29.4	23.8	22.5	22.9	67	Cape Verde	39.8	34.9	40.1	35.5
27	Kuwait	46.3	19.2	58.0	22.9	68	Venezuela	31.3	31.3	45.8	35.7
28	Italy	25.8	28.8	19.5	23.4	69	Cyprus	16.5	22.7	25.5	36.3
29	Uruguay	24.3	18.1	33.7	24.6	70	Indonesia	21.7	20.8	42.5	36.6
30	Croatia	20.9	20.7	24.8	24.7	71	Thailand	18.0	18.8	36.1	37.7
31	Tunisia	12.7	11.7	25.7	25.0	72	Lebanon	23.0	22.7	39.7	37.8
32	New Zealand	30.7	28.5	25.9	25.2	73	El Salvador	18.0	20.3	34.5	38.3
33	Serbia	9.0	13.7	14.7	25.3	74	Jamaica	30.0	22.2	52.4	38.5
34	Fiji	26.1	20.3	26.4	25.4	75	Korea (Rep.)	20.3	25.3	26.6	39.8
35	Moldova	23.2	13.4	43.7	25.4	76	Bahrain	26.7	26.3	40.2	40.2
36	Ireland	38.1	36.4	25.2	25.7	77	Hungary	24.8	30.3	29.5	40.8
37	Morocco	20.0	16.8	31.1	26.4	78	Grenada	29.3	29.3	43.5	41.3
38	Spain	28.8	28.8	25.4	26.5	79	South Africa	26.3	26.9	47.1	42.9
39	France	38.0	36.1	27.4	27.0	80	Philippines	23.4	21.6	45.0	43.5
40	Algeria	17.3	15.4	30.8	27.0	81	Paraguay	35.0	21.6	65.7	44.5
41	Sweden	32.3	35.5	22.0	27.1	82	Viet Nam	17.0	15.4	53.2	44.7

Rank	Country	Broadband sub-basket (US\$)		Broadband sub-basket (PPP\$)		Rank	Country	Broadband sub-basket (US\$)		Broadband sub-basket (PPP\$)	
		2008	2009	2008	2009			2008	2009	2008	2009
83	Albania	31.4	22.0	53.1	45.6	124	Mali	58.2	55.4	101.6	91.6
84	Sudan	29.1	23.3	51.8	45.7	125	Suriname	95.0	79.9	153.0	107.4
85	Jordan	30.9	30.4	54.7	47.3	126	Djibouti		55.9		116.6
86	St. Lucia	55.2	29.3	96.7	48.7	127	Botswana	29.6	62.2	65.3	118.3
87	Dominican Rep.	28.0	26.3	50.8	48.7	128	Ghana	64.4	44.4	114.7	122.9
88	Oman	31.3	31.3	51.6	49.4	129	Mauritania	62.4	57.8	127.1	127.1
89	Pakistan	18.5	14.6	56.5	50.2	130	Bangladesh	53.9	50.4	155.1	135.9
90	Micronesia	40.0	40.0	52.8	50.9	131	Seychelles	50.7	57.1	114.1	137.4
91	Czech Republic	28.9	43.3	33.3	52.2	132	Kyrgyzstan	-	48.1	-	149.4
92	Montenegro	21.3	29.0	33.0	52.7	133	Cameroon	183.8	88.6	314.4	159.8
93	Syria	51.3	31.5	114.3	53.2	134	Tonga	109.8	127.8	157.3	164.4
94	St. Kitts and Nevis	-	36.7	-	54.0	135	Mozambique	100.1	80.2	203.8	174.5
95	Malta	21.1	20.1	22.1	54.4	136	Tanzania	68.0	63.6	194.1	180.0
96	Colombia	36.3	34.8	59.9	55.4	137	Nigeria	690.1	105.0	1,122.9	197.4
97	Barbados	49.4	34.5	80.0	55.8	138	Rwanda	91.8	88.0	231.0	203.8
98	United Arab Emirates	21.5	40.6	32.4	56.2	139	Burkina Faso	1,861.0	91.3	4,098.5	204.4
99	St. Vincent and the Gren.	55.2	33.7	92.4	56.6	140	Angola	163.6	157.4	253.6	208.0
100	Armenia	39.2	31.5	65.5	61.5	141	Benin	104.7	117.7	204.9	225.7
101	Guatemala	34.0	34.4	61.1	63.3	142	Madagascar	120.1	101.6	262.4	243.6
102	Nepal	22.8	21.5	60.6	64.1	143	Papua New Guinea	144.3	141.8	263.0	244.7
103	Côte d'Ivoire	46.5	44.3	68.8	64.9	144	Cambodia	90.6	88.5	271.8	245.0
104	Senegal	29.1	39.9	48.4	65.5	145	Vanuatu	450.0	168.2	787.2	252.4
105	Argentina	38.4	31.2	76.7	66.0	146	Togo	105.8	186.1	202.6	355.9
106	Namibia	46.1	47.2	78.8	66.2	147	S. Tomé & Príncipe	273.5	207.3	521.7	357.7
107	Peru	36.4	36.5	67.3	69.1	148	Lao P.D.R.	268.3	194.3	772.0	467.6
108	Antigua & Barbuda	-	47.8	-	71.2	149	Yemen	225.7	219.9	525.1	469.1
109	Chile	53.0	48.2	67.2	71.2	150	Niger	58.2	265.9	111.4	502.2
110	Iran (I.R.)	43.0	30.5	123.2	71.6	151	Uganda	170.0	194.4	412.9	558.0
111	Qatar	-	55.0	-	72.9	152	Uzbekistan	-	199.5	-	588.4
112	Zambia	91.5	51.4	116.1	76.3	153	Comoros	449.7	428.4	646.4	612.7
113	Kenya	167.8	39.8	318.6	77.0	154	Samoa	169.3	469.0	249.6	667.3
114	Azerbaijan	84.5	48.8	167.3	78.1	155	Guinea	800.0	502.5	1,897.3	990.4
115	Myanmar	-	28.5	-	78.4	156	Gambia	383.8	307.3	1,051.8	1,033.5
116	Georgia	47.6	42.2	84.5	78.4	157	Tajikistan	-	363.6	-	1,183.6
117	Ecuador	39.9	39.9	89.1	81.9	158	Malawi	900.0	492.6	2,674.2	1,379.6
118	Guyana	49.5	49.4	105.2	82.0	159	Swaziland	1,877.5	858.0	3,854.1	1,691.7
119	Dominica	47.8	47.8	84.2	83.5	160	Ethiopia	644.0	486.5	2,198.0	1,739.3
120	Bolivia	33.5	35.2	95.3	84.1	161	Central African Rep.	1,395.8	1,329.5	2,266.4	2,213.1
121	Nicaragua	30.0	34.4	79.6	84.6	162	Cuba	1,630.0	-	-	-
122	Belize	89.5	55.0	146.5	86.7	163	Taiwan, China	10.3	-	17.6	-
123	Lesotho	48.9	50.0	101.5	88.3						

Source: ITU – Measuring the Information Society 2009, 2010.

Figure 4: Fixed broadband Internet sub-basket 2008 (ranked by USD PPP 2009)

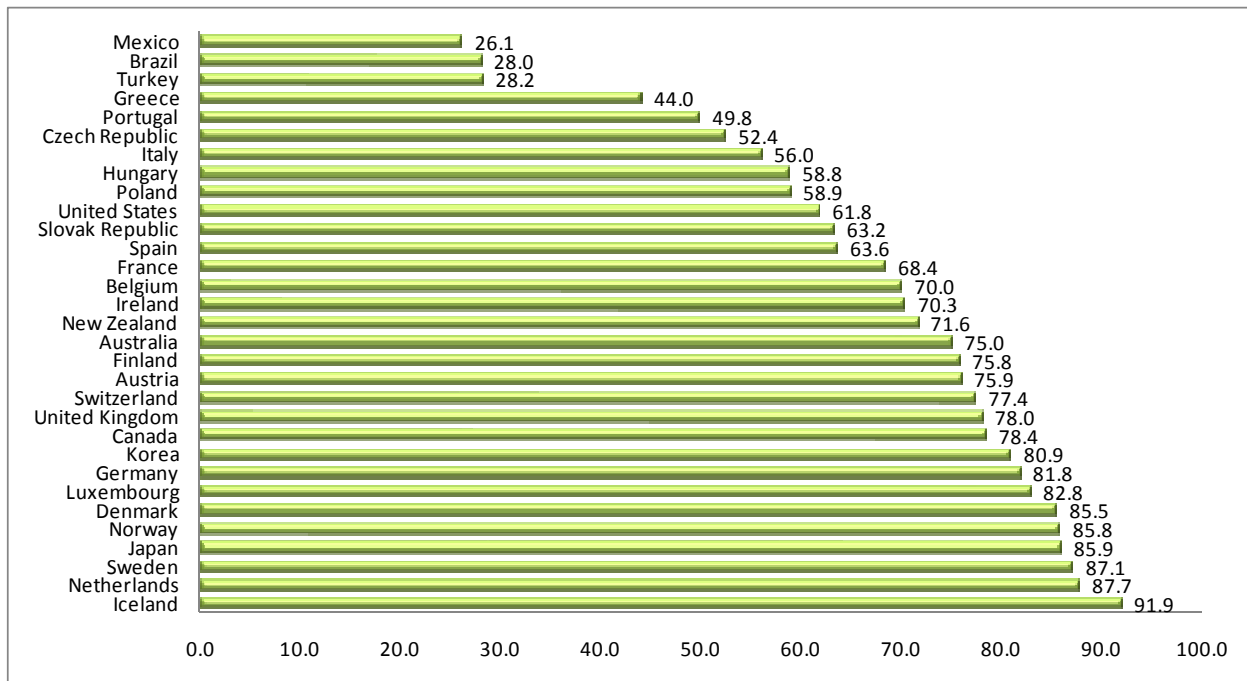
According to the ranking above, Brazil is ranked 63rd among 163 countries. Even though that is not an enviable position, the price of the broadband basket in Brazil fell from 47.3 to 28 (in US\$) and from 56.5 to 34.1 (in PPP\$⁶) from 2008 to 2009, a

⁶ PPP\$ stands for Purchasing Power Parity dollars.

drop of around 40%. At any rate, clearly there is a lot of room for prices to decrease before broadband in Brazil becomes as affordable as in more top ranked countries.

Households with access to computer

When compared to OECD countries, Brazil occupies the next to last position in terms of percentage of households with access to a computer at home. Only Mexico is behind Brazil in this category.



Sources: OECD; Cetic.br – Pesquisa sobre o uso das TICs no Brasil 2008.

Note: The latest official numbers available for Switzerland, Canada, Australia, New Zealand, the United States and Turkey are from 2006, 2007, 2007, 2006, 2003 and 2005, respectively. The number for Brazil refers to urban households only.

Figure 5: Percentage of households with access to a computer at home– 2008

The relatively small share of households with a computer is in all likelihood one of the reasons for the low broadband penetration rate in Brazil. This conjecture will be investigated in the econometric analysis to be presented later. On the other hand, it is also an indication of the great potential for the growth of broadband market in Brazil.

Type of connection

The last indicator we look at when comparing Brazil to other countries is the distribution of broadband connections by technology. The table below presents the latest data available for Brazil and OECD countries⁷.

⁷ As in all the other tables and figures based on OECD data, only fixed broadband connections are included.

Country	DSL	Cable	Fiber/LAN	Other	Total
Netherlands	22.5	13.7	1.1	0.8	38.1
Denmark	22.4	9.9	3.9	0.9	37.0
Norway	22.7	7.7	3.5	0.7	34.5
Switzerland	23.3	10.0	0.2	0.3	33.8
Korea	7.2	10.5	15.1	0.0	32.8
Iceland	30.7	0.0	1.3	0.7	32.8
Sweden	18.5	6.3	6.7	0.1	31.6
Luxembourg	26.0	5.3	0.0	0.0	31.3
Finland	24.9	4.1	0.0	0.8	29.7
Canada	13.2	15.2	0.0	1.3	29.7
Germany	26.7	2.4	0.1	0.1	29.3
France	27.5	1.6	0.1	0.0	29.1
United Kingdom	22.8	6.1	0.0	0.1	28.9
Belgium	16.3	11.8	0.0	0.2	28.4
United States	10.3	13.8	1.6	0.9	26.7
Australia	19.4	4.3	0.0	1.2	24.9
Japan	8.5	3.3	12.4	0.0	24.2
New Zealand	20.4	1.4	0.0	1.0	22.8
Austria	14.5	6.8	0.1	0.5	21.8
Ireland	15.5	2.8	0.1	3.0	21.4
Spain	16.6	4.0	0.1	0.2	20.8
Italy	19.2	0.0	0.5	0.1	19.8
Czech Republic	7.0	3.9	0.9	6.3	18.1
Portugal	10.0	6.7	0.1	0.2	17.0
Greece	17.0	0.0	0.0	0.0	17.0
Hungary	8.2	7.6	1.0	0.0	16.8
Slovak Republic	6.6	1.3	2.7	2.0	12.6
Poland	7.4	3.7	0.1	0.1	11.3
Turkey	8.5	0.1	0.0	0.0	8.7
Mexico	6.3	1.9	0.0	0.2	8.4
OECD	13.7	6.6	2.1	0.5	22.8
Brasil	3.9	1.5	--	0.2	5.6

Sources: OECD and Teleco (Brazil).

The data available at www.teleco.com.br does not include dedicated IP (business), mobile and satellite connections. There is no separate category for fiber connections.

Table 6: Broadband connections per 100 inhabitants, by technology – June 2009

A striking feature of the distribution of broadband connections by technology in Brazil is the low share of cable. The average cable broadband penetration in the OECD is more than 4 times greater than that in Brazil, although the latter is larger than those observed in Iceland, Italy, Greece, and Turkey, and similar to those of the Slovak Republic, France, New Zealand and Mexico.

The next table shows the recent evolution of broadband connections in Brazil by technology.

Technology	1Q08	2Q08	3Q08	4Q08	1Q09	2Q09	3Q09	4Q09
ADSL	5,936	6,322	6,706	7,001	7,256	7,494	7,507	7,705
Cable	1,943	2,100	2,431	2,589	2,680	2,835	3,020	3,132
Other	405	415	420	420	424	425	500	550
Total	8,284	8,837	9,557	10,010	10,360	10,754	11,027	11,387
Connections/100 inhabitants	4.4	4.7	5.0	5.3	5.4	5.6	5.8	5.9

Source: Teleco (www.teleco.com.br)

Table 7: Evolution of broadband connections in Brazil, by technology

Notice that cable broadband connections grew consistently at a faster pace than ADSL connections from the first quarter of 2008 to the fourth quarter of 2009, but the ratio of ADSL to cable connections seems to have stabilized around 2.5 as of late.

In the next section we claim that competition between different types of technology, especially between DSL and cable, is an important driver of broadband penetration growth. This suggests there is a need for faster deployment of broadband technologies other than DSL in order to foster the development of the Brazilian broadband market⁸.

DRIVERS OF BROADBAND PENETRATION

It should be clear from the previous analysis that the Brazilian broadband market is still incipient and needs to be stimulated. Most countries use regulatory and other types of public policy to provide that stimulus. It is the goal of this section to identify the likely drivers of broadband penetration and thus generate input for public policies and other studies of broadband in Brazil.

The empirical analysis is based on a panel constructed mainly from data available in the *OECD Communications Outlook 2009* and the website OECD.stat. Data from the International Telecommunication Union and the World Bank was also used.

There are several studies in the literature that seek to identify factors in broadband expansion, but most are content with comparing national broadband markets and finding patterns that lead to the identification of broadband drivers⁹. An exception is Cava-Ferreruela and Alabau-Muñoz, 2006, who use OECD data to perform an empirical analysis of the determinants of broadband supply and demand. Their results suggest that the main drivers of broadband penetration are facilities competition (the existence of more than one type (technology) of broadband network), the cost of network deployment, and the willingness of individuals to use new technologies.

The Cava-Ferreruela and Alabau-Muñoz study uses data from 2000 to 2002, when broadband was still an incipient market even in OECD countries. In addition, the specification of the model they estimated is not without flaws. In this section we use recent data to test the validity of the conjecture that broadband penetration depends significantly on facilities competition. We also identify other drivers of broadband penetration, as described below.

A preliminary descriptive analysis (not shown in this paper) identified the following candidates for explanatory variable: Per capita GDP, number of cable TV subscribers per 100 inhabitants, percentage of urban population, and percentage of population with access to computer.

It is important to mention that our choice of variables was constrained by the (lack of) data. For instance, the variable we use to measure competition between DSL and cable (number of cable TV subscribers per 100 inhabitants) is not ideal. One could argue that an eventual positive and significant estimated coefficient for this variable would not be surprising, since a fraction of cable TV subscribers also subscribe to broadband services (from the same company), and these broadband subscribers are included in the computation of broadband penetration, the dependent variable. Nevertheless, the number of cable TV subscribers per 100 inhabitants is a measure, albeit imperfect, of the availability of cable broadband services, and as such captures at least partially the competition between cable and DSL. In addition, the results presented below point to a positive effect of an increase in the number of cable TV subscribers on broadband penetration, on average, everything else the same.

⁸ For analyses of the impact of competition on investments in telecommunications see, for instance, Inung, Gayle and Lehman, 2008; Hassett and Kotlikoff, 2002.

⁹ See, for instance, Picot and Wernick, 2007; Wu, 2004.

This implies, from the point of view of regulatory and antitrust policies, that an expansion of cable TV and broadband should be incentivized.

The regression model we estimated is given below:¹⁰

$$BP_{it} = \alpha_0 + \alpha_1 GDP_{it} + \alpha_2 CABSUB_{it} + \alpha_3 URBPOP_{it} + \alpha_4 COMP_{it} + v_i + \varepsilon_{it}, \quad i = 1, \dots, N, \quad t = 1, \dots, T.$$

The variables included in the model are the following:

- BP: Number of broadband subscribers using any type of connection, per 100 inhabitants (Source: OECD Communications Outlook 2009)
- GDPCAP: GDP per capita in constant US dollars. (Source: OECD.stat)
- CABSUB: Number of cable TV subscribers per 100 inhabitants. (Source: OECD Communications Outlook 2009)
- URBPOP: Percentage of urban population. (Source: World Bank)
- COMP: Percentage of households with personal computer. (Source: International Telecommunication Union – ITU)

The table below brings the results of the estimation.

Dependent variable: BP				
Model: Fixed effects				
Explanatory variable	Coefficient	Standard error	t statistic	Prob > t
GDPCAP	0.001098	0.0005618	1.95	0.057
CABSUB	0.8088672	0.2850742	2.84	0.007
URBPOP	2.266825	1.127573	2.01	0.051
COMP	0.1899185	0.078282	2.43	0.020
CONSTANT	-210.1398	79.2791	-2.65	0.011
Number of observations		74		
R^2 within *		0.7171		
R^2 between *		0.1471		
R^2 overall *		0.1112		
F statistic (Prob > F)		26.62 (0.000)		

Note: Regressions were run with Stata.

Table 8: Estimation results (fixed effects)

¹⁰ It is important to emphasize that this is not the reduced form of a system of demand and supply equations, since price is not a variable. Unfortunately, the price data we were able to obtain was not appropriate for running regressions.

Upon first inspection, we observe that all explanatory variables, including the constant, are significant at 10%. In addition, the model provides a good fit to the data. The R² within, the relevant coefficient of determination for fixed effects estimation¹¹, is a little below 72%, a reasonable fit. The coefficient signs are as expected. The GDPCAP coefficient of 0.001098 is relatively small, but significant. It points to a positive effect of GDP per capita on broadband penetration. The coefficients of URBPOP and COMP are also positive and equal to 2.266825 and 0.1899185, respectively. Since their absolute values are not important for the type of analysis we are carrying out here, we will not discuss them any further. The coefficient we are most interested in is that of CABSUB, equal to 0.8088672. This means that the addition of one cable TV subscriber per 100 inhabitants leads to an increase of 0.81 broadband subscriber per 100 inhabitants. This effect is substantial, especially if we take into account the fact that Cable TV penetration is much higher than cable broadband penetration.

The absolute value of the CABSUB coefficient is not as important as its sign, which tells us that competition between cable and DSL broadband technologies is a significant driver of broadband expansion. Since this type of competition is not sufficiently strong in Brazil, as argued in the previous section, any debate about broadband development in Brazil should include a discussion about regulatory and antitrust policies that can foster the deployment of new broadband facilities, including fiber-to-the-home and mobile networks.

SIMULATIONS OF BROADBAND PENETRATION AND PRICES IN BRAZIL

In this section we simulate the future behavior of broadband penetration and prices in Brazil under different scenarios. The scenarios differ in terms of the penetration growth rates assumed. In order to carry out the simulations, we use as benchmark the OECD average growth rates of broadband penetration.

In scenario 1, growth rates are the same as OECD average growth rates. Scenario 2 growth rates start at the level of the observed Brazilian broadband average growth rate as of late, and then decelerate. In scenario 3, the growth rate increases by 10% each year. The numbers for the three scenarios are found in the table below:

Scenarios	Year 1	Year 2	Year 3	Year 4	Year 5
Scenario 1	49.38%	40.70%	31.61%	26.48%	17.82%
Scenario 2	35.00%	28.85%	22.41%	18.77%	12.63%
Scenario 3	54.32%	44.77%	34.77%	29.13%	19.60%

Source: Authors' calculations.

Table 9: Broadband penetration growth rates under different scenarios

We can now compute future broadband penetration rates for Brazil and its geographic regions. This is done by applying the growth rates for each scenario to a base broadband penetration rate, as detailed in the table below. There are separate scenarios for each geographic region.

¹¹ A fixed effects model eliminates the problem of time-independent but state-dependent omitted variables. That is one of the main reasons why we opted for this model instead of a random effects model. Another reason was the fact that fixed effects models are recommended when observations are not randomly drawn from a large population, as is the case of our data, a subset of countries.

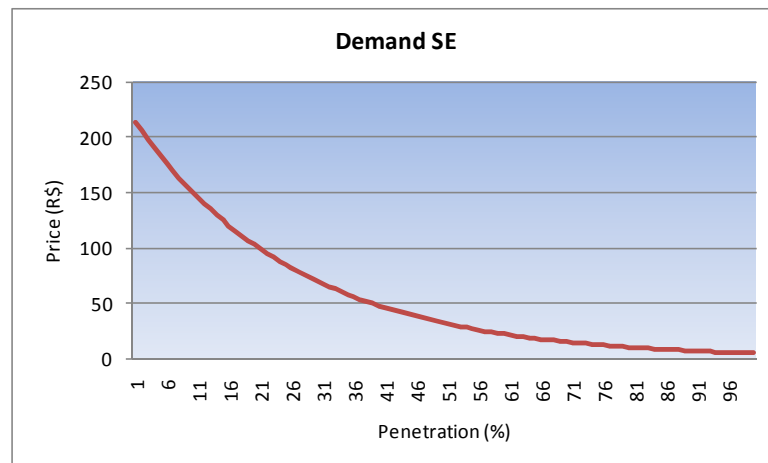
Scenarios	Base	Year 1	Year 2	Year 3	Year 4	Year 5
Scenario 1						
Southeast	5.80%	8.89%	12.80%	17.16%	22.07%	26.31%
Northeast	1.00%	1.60%	2.39%	3.31%	4.37%	5.32%
South	5.90%	8.47%	11.51%	14.71%	18.15%	21.00%
North	2.70%	4.02%	5.65%	7.42%	9.36%	11.02%
Midwest	4.70%	6.05%	7.48%	8.85%	10.22%	11.27%
Brazil	4.60%	6.87%	9.67%	12.72%	16.09%	18.96%
Scenario 2						
Southeast	5.80%	7.99%	10.48%	13.01%	15.65%	17.78%
Northeast	1.00%	1.43%	1.92%	2.45%	3.01%	3.47%
South	5.90%	7.72%	9.68%	11.60%	13.51%	15.02%
North	2.70%	3.64%	4.68%	5.72%	6.78%	7.63%
Midwest	4.70%	5.66%	6.60%	7.46%	8.28%	8.89%
Brazil	4.60%	6.21%	8.00%	9.79%	11.63%	13.10%
Scenario 3						
Southeast	5.80%	9.20%	13.65%	18.77%	24.67%	29.89%
Northeast	1.00%	1.66%	2.56%	3.64%	4.93%	6.11%
South	5.90%	8.72%	12.17%	15.90%	19.98%	23.43%
North	2.70%	4.15%	6.00%	8.07%	10.40%	12.42%
Midwest	4.70%	6.18%	7.79%	9.37%	10.95%	12.20%
Brazil	4.60%	7.10%	10.28%	13.85%	17.89%	21.39%

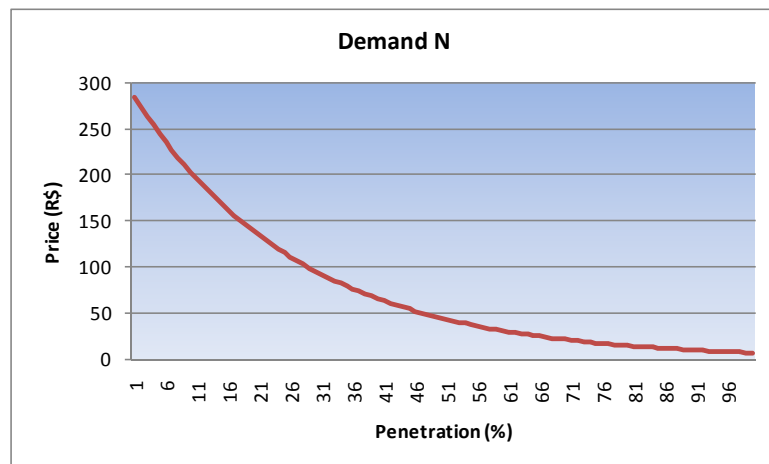
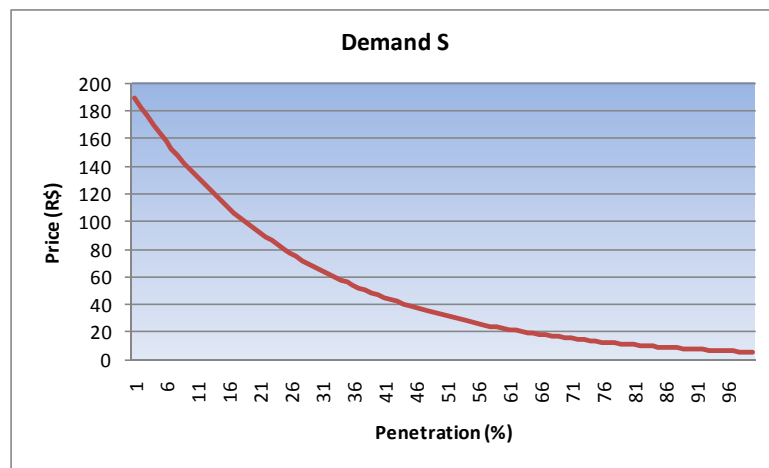
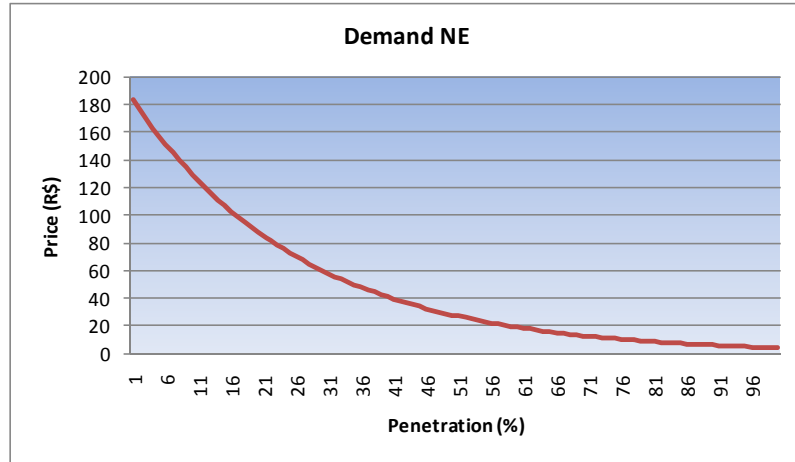
Source: Authors' calculations.

Table 10: Scenarios of broadband penetration rates: Brazil and geographic regions

According to our projections, in two years the broadband penetration rate in Brazil will be approximately 8% under scenario 2, 10.28% under scenario 3, and 9.67% under scenario 1. After five years it will be around 13.10% if scenario 2 materializes, 21.39% under scenario 3, and 18.96% in case scenario 1 occurs. It is evident then that the cost, in terms of lower penetration rates, of misguided broadband policies can be substantial.

We will now use these scenarios to simulate future broadband prices. We first estimate demand curves for each geographic region using data on the maximum amount individual are willing to pay for access to the internet. This information can be found in a study named *Pesquisa sobre o uso das TICs no Brasil 2007*, published by Cetic.br.





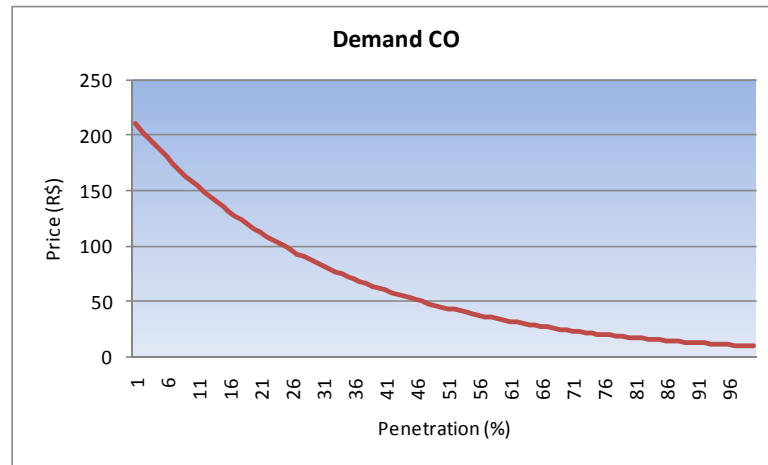


Figure 6: “Demand curves” by geographic region

We ran several regressions with price as the dependent variable and broadband penetration as the explanatory variable, and finally settled on a model where the natural log of price is equal to a constant plus broadband penetration (measured in percentage of the population)¹². The “demand curves” shown above were drawn based on that model.

We now plug the penetration rates computed above into our equation for prices to obtain the numbers shown below:

Scenarios	Year 1	Year 2	Year 3	Year 4	Year 5
Scenario 1					
Southeast	157.91	135.88	114.87	95.12	80.79
Northeast	179.04	173.68	167.67	160.95	155.21
South	144.78	129.82	115.71	102.30	92.35
North	254.15	239.07	223.65	207.83	195.27
Midwest	179.50	171.60	164.33	157.43	152.27
Scenario 2					
Southeast	163.48	148.56	134.76	121.76	112.17
Northeast	180.25	176.82	173.30	169.63	166.65
South	148.72	138.60	129.41	120.80	114.45
North	257.87	247.95	238.43	229.06	221.85
Midwest	181.74	176.39	171.68	167.33	164.16
Scenario 3					
Southeast	156.05	131.52	108.00	86.07	70.41
Northeast	178.63	172.54	165.52	157.52	150.57
South	143.45	126.77	110.89	95.78	84.62
North	252.89	235.91	218.22	199.88	185.23
Midwest	178.74	169.91	161.69	153.82	147.89

Source: Authors’ calculations.

Table 11: Estimated broadband prices (R\$ per month)

Upon inspection, we observe that prices in the North region are the highest under any scenario. Another finding is that price reductions over time are substantial. For instance, prices in the South region fall between 10% (scenario 1) and 12% (scenario

¹² Estimation results are available from the authors upon request.

3) after 2 years, and between 36% (scenario 1) and 41% (scenario 3) after 5 years. A similar is observed in the Northeast and Midwest regions.

Notice how prices differ significantly depending on the scenario utilized. Once again, this is evidence that public policies and plans for broadband development must be well designed and thought out, otherwise the cost in terms of delayed broadband expansion and price reduction can be high.

CONCLUSION

In this study we investigated the main drivers of broadband expansion based on OECD data and applied the results to the Brazilian broadband market. Our estimations indicated that GDP per capita, urban population and ownership of personal computers all have statistically significant and positive effects on broadband penetration. In addition, the number of TV subscribers per 100 inhabitants has a positive and significant impact on broadband penetration. We interpreted this as evidence that facilities-based competition has, on average, played an important role in the development of high-speed networks and broadband services in OECD countries and is therefore an important element of broadband expansion. Since broadband markets in Brazil lack the necessary network competition for broadband services to expand at desirable rates, public policies in Brazil should put a premium on curbing anti-competitive practices in broadband markets and fostering the deployment of alternative (to DSL) broadband networks.

We also carry out simulations of future broadband penetration and prices in Brazil based on different scenarios of broadband growth rate. Our results show that broadband penetration rates and prices vary considerably with the scenario, yet another indication of how important it is for public broadband policies, especially regulatory and antitrust policies, to be well designed.

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