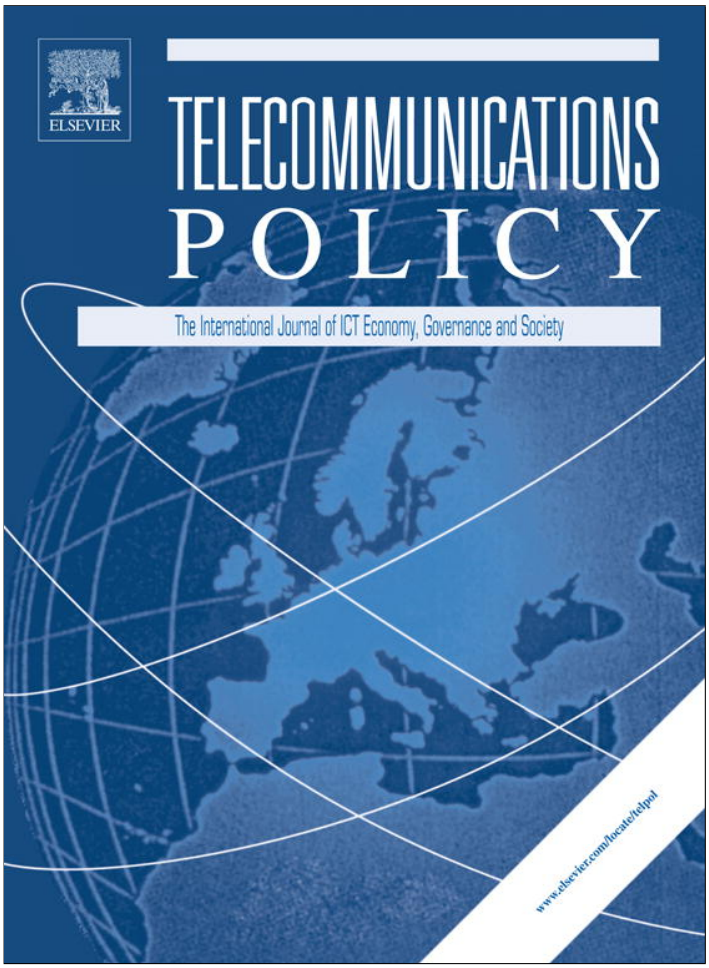

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Price elasticity of demand for broadband: Evidence from Latin America and the Caribbean

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ABSTRACT

In this study the authors analyze fixed broadband retail prices in Latin America and the Caribbean (LAC), and provide estimates about the effect of price changes on broadband adoption. The analysis is based on a survey of plans and tariffs conducted by the authors during Q2 2010. Their results suggest that fixed broadband services in LAC are generally expensive and of poor quality when benchmarked against Organisation for Economic Co-operation and Development (OECD) countries, although there is significant variance between markets in the region. In order to isolate the effect of prices on broadband adoption they use an instrumental-variable approach. Their findings show that broadband demand is relatively elastic to price in LAC but not in the OECD. They estimate that an average price reduction of 10% would result in an increase of almost 22% in the penetration rate in LAC, equivalent to almost 8.5 million additional broadband connections. Several policy implications result from these findings. First, national broadband policies in LAC should pay a closer attention to a deficit of competition in fixed broadband services, as households and firms face high prices for poor quality services, thus deterring adoption. Second, while their findings generally suggest that price reductions could significantly increase penetration, they elasticity estimates reveal that price effects might not be sufficient to achieve the penetration goals set in national broadband plans. This validates the need for complementary policy strategies that affect other determinants of broadband demand. The example of Brazil is used to illustrate this finding.

1. Introduction

National initiatives to promote the development of broadband have flourished in Latin America and the Caribbean (LAC) since 2008. These initiatives contemplate ambitious targets to increase broadband adoption in the region, which lag considerably in comparison to OECD countries (Jordan, Galperin, & Peres, 2011). While national broadband plans vary significantly in scale and policy instruments, most seek to achieve significant reductions in retail prices in order to spur demand by households and firms. Estimating the own-price elasticity for broadband demand is therefore critical for setting realistic penetration targets, and more broadly for the efficient allocation of resources in national broadband plans.

There is a considerable literature about the determinants of broadband diffusion across countries (Chinn & Fairlie, 2010; Močnik & Širec, 2010; Wallsten, 2005), and yet few of these studies take retail prices into account. This omission is due in part to lack of comparable data, as regulators in developing countries often do not track ISP prices systematically. Furthermore, most of the existing literature fails to address the potential endogeneity between broadband prices and adoption, which results in biased estimates about the relationship between retail tariffs and broadband penetration.

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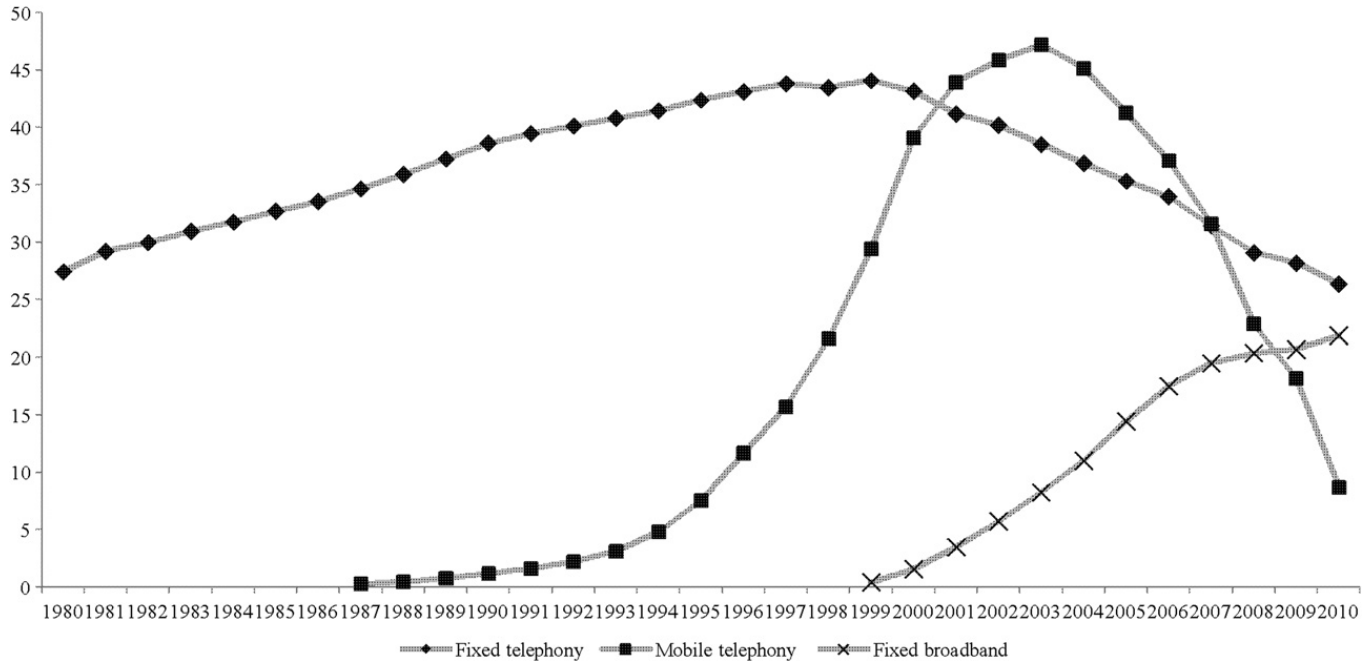

Fig. 1. Access gap between OECD and Latin America and the Caribbean, by type of service, 1980–2010 (in percentage points).
Source: ITU, World Telecommunications Indicators Database, 2011.

In this study the authors analyze fixed broadband retail prices in LAC, both within the region and benchmarked against OECD countries, and provide estimates about the effect of price variations on broadband adoption. The analysis is based on a survey of plans and tariffs conducted by the authors during Q2 2010, which covered 323 service plans offered by 54 operators in 23 countries in the region.[2] Their results suggest that fixed broadband services in LAC are generally expensive and of poor quality when benchmarked against OECD countries, although there is significant variance between markets in the region. In order to isolate the effect of prices on broadband adoption they use an instrumental-variable approach to estimate broadband demand across countries. Their findings show that broadband demand is relatively elastic to price in LAC but not in the OECD. They estimate that an average price reduction of 10% would result in an increase of almost 22% in the penetration rate in LAC, equivalent to almost 8.5 million additional broadband connections.

Several policy implications result from these findings. First, national broadband policies should pay a closer attention to a deficit of competition in fixed broadband services, as households and firms in LAC face high prices for poor quality services, thus deterring adoption. Second, while their findings generally suggest that price reductions could significantly increase penetration, their elasticity estimates reveal that price effects might not be sufficient to achieve the penetration goals set in national broadband plans. This validates the need for complementary policy strategies that affect other determinants of broadband demand, in particular equipment affordability, digital literacy and availability of relevant applications and content.

The paper is organized as follows. In Section 2 they provide background statistics about broadband adoption and price/quality levels in LAC. In Section 3 the econometric model is described and results are discussed. Section 4 discusses the policy implications of the findings and demonstrates how results can be applied to the case of Brazil, the largest broadband market in the region. Section 5 provides brief concluding remarks.

2. Catching up to a moving target

Broadband adoption has grown exponentially in LAC over the last decade, with fixed broadband subscriptions growing at a compound annual growth rate of 76% between 2000 and 2010 (ECLAC, 2011). Despite such strong market performance the region still lags significantly in broadband adoption when compared to OECD countries. As Fig. 1 shows this broadband adoption gap has been relatively stable over the past years, while adoption gaps for other services (in particular mobile telephony) have decreased significantly in the same period. Market expansion in LAC has slowed in recent years, with annual growth below 20% for 2010, prompting policymakers to adopt a more proactive approach towards broadband deployment.

[2] Mobile broadband services are not included in the analysis for two main reasons: first, because of the inconclusive evidence about whether fixed and mobile broadband are complements or substitutes (see OFCOM, 2010a); and second, because of the difficulties in comparing quality levels between fixed and mobile access services (see OFCOM, 2010b).

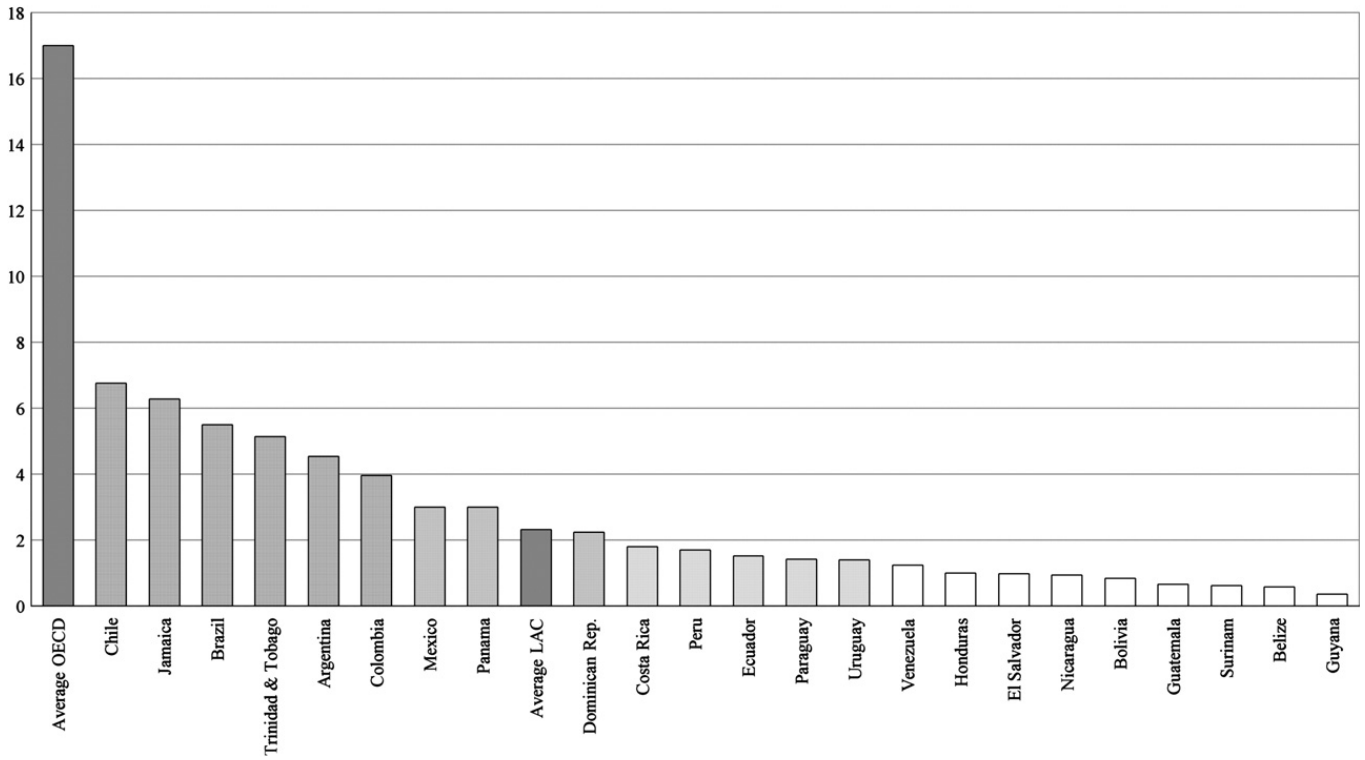

Fig. 2. Average advertised download speed, Q2 2010 (in Mbps).
Source: authors' survey.

Part of the problem lies in the fact that broadband is a moving target. As Fig. 2 shows, the average advertised download speed in LAC is seven times lower than the OECD average. Residential broadband services with download speeds of 10 Mbps have become standard in OECD, but they are rare in LAC. Catching up to developed markets thus involves not only expanding the market but also following upward trends in service quality as fiber moves closer to subscribers (OECD, 2011).

The literature about the determinants of broadband adoption across countries has emphasized two sets of factors: on the one hand, endowment factors such as wealth, geography and demographics, over which policymakers can exercise little impact in the short to medium term (e.g., Chinn & Fairlie, 2010; Ford, Koutsky, & Spiwak, 2007); on the other hand, regulatory factors that shape market competition, upon which national broadband policies have typically focused (e.g., Wallsten, 2005; Ware & Dippon, 2010). A recent subset of the latter has emphasized the role of retail prices as a key determinant of broadband adoption, and the findings have prompted calls for a more explicit policy focus on reducing access prices (Greenstein & McDevitt, 2010; Macedo & Carvalho, 2011).

Price benchmarks suggest a deficit of infrastructure investment and competition among fixed broadband markets in LAC. Their survey reveals that average retail prices in LAC are 2.5 higher than in the OECD. When standardized on a US$ (PPP) per Mbps basis, average subscription prices in the region are over 15 times higher than in the OECD markets, though as Fig. 3 shows significant variation exists within the region.

There seems to be little question that the existing supply of high-priced and low-quality broadband services has an inhibitory effect on adoption in the region. Fig. 4 shows this relationship for the 23 LAC and the 29 OECD countries included in their sample: the higher the prices the lower the fixed broadband penetration (per 100 households). However, as Hauge and Prieger (2010) argue, broadband adoption is determined by the interaction between service availability, the type of plans offered and household/firm demand. In other words, price and penetration are determined simultaneously, which requires other econometric tools to estimate the effect of price changes on broadband adoption. This is addressed in the next section.

3. Estimating the effect of price on broadband demand

3.1. Econometric model and data sources

In order to isolate the effect of price on broadband demand the authors start by estimating a simple regression model that considers four demand factors identified by the literature as key determinants of the level of broadband penetration (number of broadband subscriptions per 100 households; *PENET*):

- *Price*: monthly subscription cost in US$ PPP (*PRICE*).
- *Income*: GDP per household in US$ PPP (*GDPCAP*).

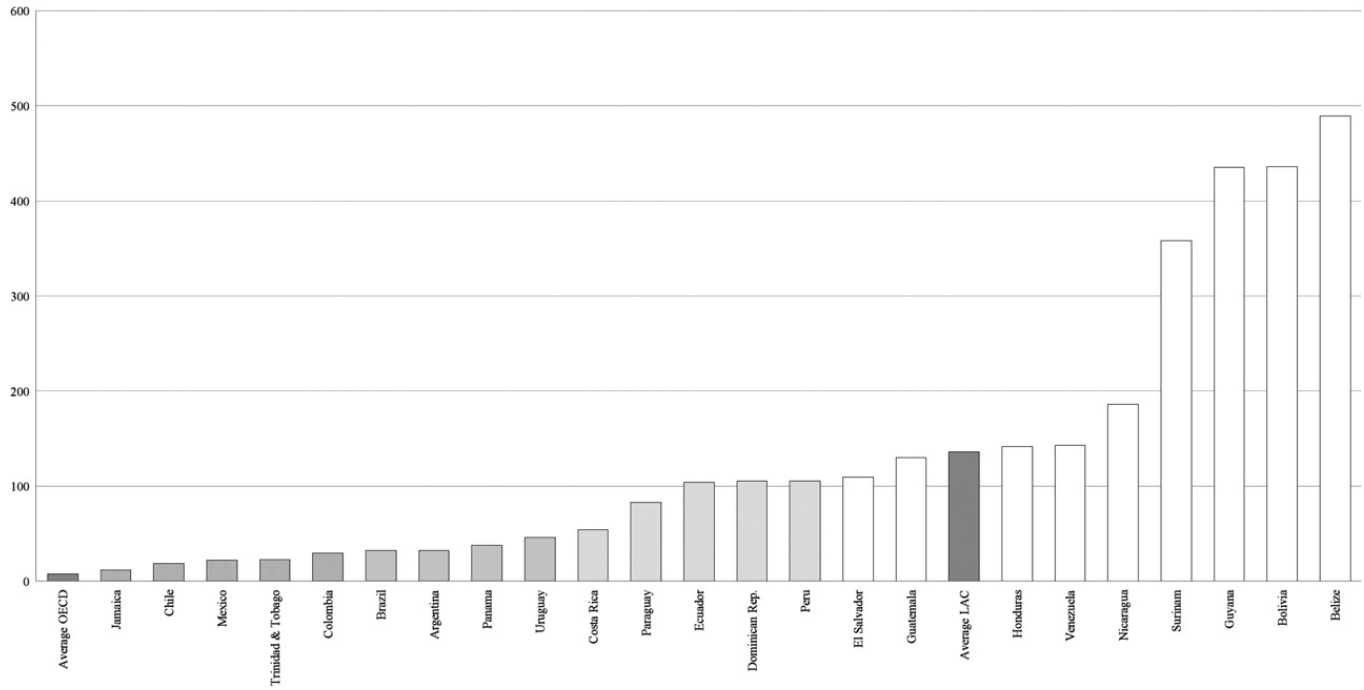

Fig. 3. Fixed broadband prices, Q2 2010 (in US$ PPP/Mbps).
Source: authors' survey.

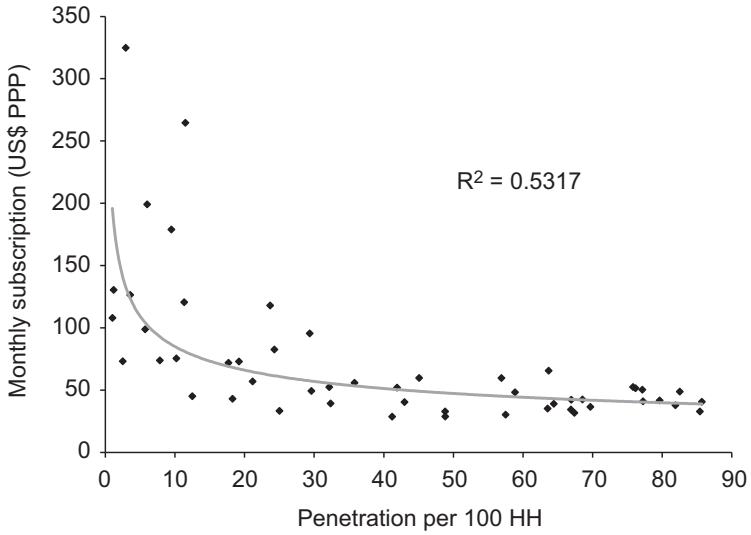

Fig. 4. Correlation between average prices (in US$ PPP) and broadband penetration (connections per 100 households) in LAC and OECD, Q2 2010.
Sources: ITU and authors' survey.

- *Age*: percentage of population aged 15–64 (*AGE*).
- *Education*: educational attainment for population aged 25 and over (*EDUC*).

In survey studies, price and digital illiteracy appear among the most frequently mentioned barriers to broadband adoption (Goldfarb & Prince, 2008; Horrigan, 2009). Digital illiteracy—the inability to use digital technologies to find, use and create information—tends to be the most important barrier among older and less educated people (Drouard, 2011; Hauge & Prieger, 2010). *AGE* and *EDUC* are thus included as proxies of digital literacy. Data on *AGE* refer to 2008 (latest year available for the full sample) and were obtained from the World Bank (World Development Indicators database), while data on *EDUC* represent the average years of schooling attained for population aged 25 and over as of 2010, and comes from the Barro-Lee Educational Attainment Data Set.[3] Due to lack of data on educational attainment Suriname is dropped from the sample.

[3] Retrieved from www.barrolee.com (accessed October 3, 2011). The authors have alternatively used educational attainment for population aged 15 and over (from the same source), the years of formal education reported by UNESCO, and the 2008 education index compiled by United Nations (which

Broadband prices for OECD countries were obtained from the OECD Broadband Portal and correspond to September 2010.[4] For LAC countries they conducted a survey of all plans and tariffs offered by the major operators in each country in the region, following the OECD's methodology guidelines to facilitate comparisons. They considered all plans advertising download speeds higher than 256 kbps. In each country, the universe of operators considered included, at a minimum, the leading provider of xDSL services (typically the former telecommunications incumbent), and the leading provider of cable modem services (when available). The data was gathered during Q2 2010 and included 323 plans offered by 54 operators in the largest city in each of the 23 countries.

For each plan, the information collected includes access technology, advertised download and upload speeds, type of contract, speed or data restrictions, and the corresponding rates in local currency (with and without tax). The information was obtained by visiting operators' web pages and through telephone calls. Bundled plans were not considered, and rates do not include modem rental fee nor access line charges. Following the criteria used by the OECD they considered both list prices and discount prices for a monthly subscription.[5] All prices (including OECD) were converted to purchasing power parity (PPP) U.S. dollars using the PPP index published by the International Monetary Fund (IMF). In the regressions, the average discount price in each country was used as their *PRICE* variable.[6]

The authors use GDP per household in US$ PPP (*GDPCAP*) as their measure of per capita income. Data on this variable correspond to 2009 and were computed as the ratio of GDP in US$ PPP (taken from the IMF World Economic Outlook Database, April 2011) to the number of households. The temporal lag in this explanatory variable is used to mitigate potential endogeneity problems since, as shown by several studies, the development of broadband has an impact on aggregate GDP (see Dattaa & Agarwal, 2004; Koutroumpis, 2009; Röller & Waverman, 2001).[7]

The selection of variables in the model responds to theoretical considerations and data availability, as well as to the need to keep the number of parameters to be estimated low, given the limited number of observations. The lack of comparable and up-to-date data on PC penetration is problematic for their estimations. However, as Chinn and Fairlie (2010) demonstrate, given that income per capita and education are strongly associated with PC penetration, the inclusion of *GDPCAP* and *EDUC* among the regressors should capture this effect, at least in part.[8]

To sum up, the broadband demand model that they estimate is as follows (the subscript indicates the observation, that is, the country):

$$PENET_i = f(PRICE_i, GDPCAP_i, AGE_i, EDUC_i) + u_i$$

$$PENET_i = \beta_0 + \beta_1 PRICE_i + \beta_2 GDPCAP_i + \beta_3 AGE_i + \beta_4 EDUC_i + u_i$$

where $PENET_i$ is the number of broadband subscriptions per 100 households in country i; $PRICE_i$-the average monthly subscription cost in US$ PPP in country i; $GDPCAP_i$-the GDP per household in US$ PPP in country i; AGE_i-the percentage of population aged 15–64 in country i; $EDUC_i$-the average years of schooling attained for population aged 25 and over in country i; and u_i-the error term.

3.2. Sample

Their initial sample includes 52 countries: 23 from Latin America and the Caribbean (Argentina, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Guyana, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Dominican Republic, Suriname, Trinidad and Tobago, Uruguay and Venezuela) and 29 from the OECD (all member countries except Mexico, which is already included in the Latin American sample). The observed penetration data (*PENET*) corresponds to end-year 2010 and was taken from the ITU database (ITU World Telecommunication Indicators 2011).

3.3. Results

3.3.1. Descriptive statistics

Table 1 presents descriptive statistics for their sample (panel A), as well as Pearson correlation coefficients among the variables used in their regression models (panel B). As expected, broadband penetration is strongly (negatively) correlated with price, as well as strongly (positively) correlated with income per capita and education. It is also positively correlated with their age indicator (percentage of population aged 15–64) which is included as a proxy for digital literacy. All coefficients are

(*footnote continued*)
comprises the illiteracy rate and the rate of enrollment in primary, secondary and tertiary schools), obtained from the World Development Indicators database. As discussed below, results are essentially unchanged.

[4] See the OECD Broadband Portal at http://www.oecd.org/document/54/0,3343,en_2649_34225_38690102_1_1_1_1,00.html (accessed October 3, 2011).

[5] Discount prices generally offer reduced rates during the first months of service. They computed the monthly average for the first year of service.

[6] Almost identical results were obtained when using list prices instead of discount prices (which include temporary discounts offered by service providers).

[7] The use of 2010 data would lead to almost identical results. The correlation between 2009 and 2010 GDP per household is 0.9975.

[8] Chinn and Fairlie (2010) show that each $1000 increase in per capita income is associated with a 1.7 percentage point increase in the number of PCs per capita, while a one year increase in average schooling is associated with a 1.5 percentage point increase in PC penetration.

Table 1
Descriptive statistics and Pearson correlations.

Panel A: descriptive statistics

Variable	N	Mean	Median	S.D.	Min.	Max.
PENET	52	45.95	43.21	28.52	2.42	93.45
PRICE	52	73.39	51.74	58.61	28.67	324.80
GDPCAP	52	66,699.34	63,213.56	38,060.31	11,127.11	222,079.60
AGE	52	65.75	66.19	3.66	53.73	72.57
EDUC	51	9.54	9.74	2.00	4.07	12.63

Panel B: Pearson correlations

Variable	*PENET*	*PRICE*	*GDPCAP*	*AGE*	*EDUC*
PENET	1.000				
PRICE	−0.619	1.000			
GDPCAP	0.823	−0.478	1.000		
AGE	0.590	−0.522	0.530	1.000	
EDUC	0.709	−0.363	0.595	0.622	1.000

Table 2
Broadband demand estimation (OLS).

Dependent variable: *PENET*

Variable	(1)	(2)
PRICE	−0.301*** (0.063) [1.000]	−0.130*** (0.034) [1.510]
GDPCAP		0.0004*** (0.0001) [1.780]
AGE		−0.178 (0.776) [2.020]
EDUC		4.498*** (1.285) [1.950]
Constant	68.046*** (5.333)	−1.972 (48.448)
Obs.	52	51
R^2	0.38	0.80
Adj. R^2	0.37	0.79
F	23.03	61.31
Prob > *F*	0.0000	0.0000

Note: Robust standard errors are reported in parentheses. Variance inflation factors are reported in brackets.
*** $p < 0.01$.
** $p < 0.05$,
* $p < 0.10$.

significantly different from zero at 1% confidence level. Overall these results are consistent with previous studies regarding the determinants of broadband penetration (Chaudhuria & Flamm, 2007; Chinn & Fairlie, 2010; Drouard, 2011, among others).

3.3.2. Regression results

Table 2 reports OLS estimates about the impact of broadband prices on penetration.[9] Results with and without controls indicate, as predicted, that countries with lower prices have higher penetration rates, and that the price impact is statistically significant. Column (1) presents a simple bivariate regression model in which price is the only explanatory variable. The coefficient has the expected sign and is significantly different from zero at the 1% confidence level. Column (2) presents a multiple regression model that includes the control variables, that is, GDP per capita, age and education. The effect of price decreases sharply, but is still significant at the 1% level. The model explains about 80% of the variance in broadband penetration. The signs of the coefficients are as expected and are significant at a 1% confidence level, except for *AGE*, which has a negative sign (but not statistically different from zero). In this specification, while it is possible to detect an effect of price on broadband demand, such effect is small. For example, according to the multiple regression model in column (2), a 10% reduction in average prices would result in only a 2% increase in penetration.[10]

Introducing the price variable in a model that attempts to explain broadband adoption is not trivial, because the level of penetration is determined by the interaction between the availability of the service, supply decisions and the demand for

[9] All regressions in this paper were run using Stata/SE 11.2 for Windows.
[10] This effect is estimated for a hypothetical observation constructed from the means of the variables for the entire sample. Similar results of a negligible effect of price on broadband demand are obtained by Chaudhuria and Flamm (2007).

the service. Therefore, price and penetration are determined simultaneously; in other words, price will be correlated with the error term in a regression of penetration on price and other explanatory variables.

In their OLS estimation price is potentially endogenous in the demand function: if broadband demand and supply were to vary over time, observed penetration and prices would reflect a set of equilibrium points (that is, intersections of broadband supply and demand). In that case, an OLS regression of penetration on price would be unable to identify neither the demand nor the supply function (Angrist & Krueger, 2001). In fact, if price is endogenous, the OLS estimation could yield inconsistent estimators of all the parameters in the regression.

The instrumental-variable method provides a solution in the case of a single endogenous regressor. To correctly capture the effect of price on broadband demand they need to find a factor that affects supply without affecting demand for the service, that is, an instrumental variable. The idea is to isolate the exogenous variability (that is, not caused by demand factors) in price in order to estimate its impact on broadband demand. They use international Internet bandwidth (in Mbps) per 100 households (*IIBW100HH*) as their instrumental variable. They compute *IIBW100HH* as the ratio of international Internet bandwidth in Mbps to the number of households in 2010, as reported by the ITU. Iceland represents an outlier case, likely because of its privileged location in the transatlantic cable routes: its reported *IIBW100HH* value is almost double of Sweden, the second highest. It is therefore dropped from the sample.[11]

To be considered a valid instrument, *IIBW100HH* must satisfy two conditions: (i) it must not be correlated with broadband demand, and (ii) it must be correlated with price. Condition (i) is their identification assumption. It must be satisfied for the instrument to be valid but, as such, cannot be tested. Therefore, it should be maintained throughout the analysis. This assumption would be invalid only if international Internet bandwidth affected broadband demand directly (that is, other than through its effect on price). Their identification assumption implies that this is not the case. Regarding condition (ii), international bandwidth is a critical cost factor for ISPs, particularly in developing countries since much of the data traffic is routed internationally and is subject to transit arrangements. Therefore, international bandwidth availability has a direct effect on domestic broadband prices (Lie, 2007; infoDev, 2005). Unlike condition (i), this condition can (and should) be tested.

They begin by verifying that there is a partial correlation between average retail prices and international bandwidth, once the effects of other exogenous variables have been taken into account. They use the *t* test and the *F* test associated with the coefficient on *IIBW100HH* in the first-stage regression of the two-stage least squares (2SLS) estimation. Table 3 shows the results of this first stage.

Both tests suggest that, conditional on the identification assumption, the instrument is valid (that is, satisfies condition (ii)), although it might be slightly weak. The use of a single instrument for the endogenous regressor minimizes this problem, if it exists, and their 2SLS estimator is median-unbiased (Angrist & Pischke, 2008). The coefficient associated to *IIBW100HH* has the expected sign and is statistically different from zero at the 1% level.

Table 4 presents the results of the estimation of broadband demand through 2SLS, which includes the *PRICE* variable instrumented by *IIBW100HH*. Results with and without controls indicate, once again, that countries with lower prices have higher penetration rates, and that price has a statistically significant impact on penetration. With the help of the instrument, the observed effect of price on broadband demand is much larger than the one suggested by the OLS estimation (Table 2, column (2)), and is statistically different from zero at the 1% level.[12]

With the results of the 2SLS estimation, they can compute the average own-price elasticity of broadband demand for the entire sample, as well as for each subgroup of countries (Table 5).

The results confirm the higher own-price elasticity of broadband demand in LAC countries (-2.20) as compared to the OECD (-0.36). According to their estimates, an average price reduction of 10% in LAC would result in an increase of 22% in the penetration rate, equivalent to about 8.5 million additional broadband connections. These overall estimates are in line with previous studies, which have found broadband demand to be relatively inelastic in mature markets but relatively elastic to price changes in emerging markets.[13]

Price effect estimates vary considerably between countries in LAC, and are thus best interpreted in context. The next section presents an application of these findings to the case of Brazil.

4. Policy example: Brazil's national broadband plan

Brazil is the largest and among the most dynamic broadband markets in LAC, with an estimated 14.1 million fixed subscriptions at the end of 2010.[14] This nonetheless represents a modest adoption rate of about 7 connections per 100

[11] The authors obtained the same results when they included a dummy variable to control for Iceland, instead of dropping the observation.

[12] The use of the alternative education proxies (cf. footnote 2) leads to very similar results. The price coefficient in all cases is only slightly larger (in absolute value), ranging from -0.700 to -0.674.

[13] For example, Ford et al. (2007) report a price elasticity estimate of -0.37 for OECD countries, while Cadman and Dineen (2008) estimate a price elasticity of -0.43 for the same group of countries. As mentioned, significantly higher elasticity estimates are reported for emerging markets. For example, Macedo and Carvalho (2011) report estimates between -1.79 and -2.16 using data from Brazilian municipalities. Survey-based studies in mature markets report somewhat higher elasticity estimates. For example, in the US, Rappoport, Kridel, Taylor, and Alleman (2002) report an elasticity of -0.59 for cable modem and of -1.46 for DSL services, while Rosston, Savage, and Waldman (2010) estimate an elasticity of demand for broadband of -0.44. Cardona, Schwarz, Yurtoglu, and Zulehner (2009), with data from Austria, estimate price elasticity to be between -0.97 and -2.61, depending on the available technologies (DSL, cable modem, and 3G).

[14] *Source*: ITU World Telecommunication Indicators ICT, 2011.

Table 3
Correlation between average broadband price and international Internet bandwidth (Mbps per 100 households).

Dependent variable: *PRICE*		
Variable	(1)	(2)
IIBW100HH	−2.334*** (0.619)	−1.308*** (0.479)
GDPCAP		−0.0002 (0.0002)
AGE		−7.122* (3.733)
EDUC		−3.685 (6.031)
Constant	94.236*** (12.071)	531.857** (217.618)
Obs.	51	50
R^2	0.17	0.37
Adj. R^2	0.15	0.32
F	14.20	6.50
Prob > *F*	0.0004	0.0003
F of excluded instruments	14.20	7.44
Prob > *F*	0.0004	0.0090

Note: robust standard errors are reported in parentheses.
*** $p < 0.01$.
** $p < 0.05$.
* $p < 0.10$.

Table 4
Broadband demand estimation (2SLS).

Dependent variable: *PENET*		
Variable	(1)	(2)
PRICE	−0.820*** (0.172)	−0.635*** (0.245)
GDPCAP		0.0002 (0.0001)
AGE		−3.521* (2.045)
EDUC		5.640** (2.817)
Constant	105.805*** (8.865)	257.533* (138.415)
Observations	51	50
R^2 (centered)	−0.82	0.11
R^2 (uncentered)	0.50	0.76
F	21.89	25.34
Prob > *F*	0.0000	0.0000

Note: robust standard errors are reported in parentheses.
*** $p < 0.01$.
** $p < 0.05$.
* $p < 0.10$.

Table 5
Estimates of broadband demand price elasticity.

	Price elasticity
Total sample	−0.58
LAC	−2.20
OECD	−0.36

inhabitants (or 24 connections per 100 households), to which the government has responded with the launch of an ambitious national plan to stimulate broadband development (known as PNBL for its Portuguese acronym). Among the PNBL's key goals is to double the number of fixed broadband connections to 30 million by 2014.

The high cost of fixed broadband services (both absolute and relative to income levels) has been identified as one of the main factors that inhibit broadband growth in Brazil (Abdala, Oliveira, Kubota, & Wohlers, 2009). Hence one of the key goals of the PNBL is to reduce access prices through a combination of tax incentives, regulatory initiatives to increase competition, and public investment in backbone infrastructure. The plan set a target price of R$35 for entry-level broadband services, which represents an almost 30% drop from existing prices in Q2 2010. Based on their findings, they can estimate the effect on adoption of this price target.

According to their model the own-price elasticity for fixed broadband in Brazil is −2.16, which is slightly below the regional average of −2.20 and in line with other estimates for the country such as in Macedo and Carvalho (2011). Assuming price elasticity remains constant, their findings suggest that the proposed 30% price drop will fall short of the PNBL's target of 30 million subscriptions. In order to achieve this goal, they estimate that a larger price drop of 52% (that is, to a monthly rate of about R$23) would be needed. Further, a more realistic assumption is that demand will become increasingly inelastic as prices drop and penetration increases, which suggests that their estimate might be conservative, and that further price reductions will be needed to double the number of fixed broadband connections in Brazil by 2014.

It is also worth noting that the 30 million subscriptions goal would result in a penetration rate of about 15 connections per 100 inhabitants in Brazil, still far from the OECD's current average of 26 connections per 100 inhabitants. This suggests that, in the long term, national broadband plans in Brazil will need to stimulate demand through variables other than price, if Brazil is to reach adoption levels comparable to the OECD. Previous research suggests that making terminal equipment more affordable, promoting digital literacy, stimulating shared access and developing local applications and content are complementary strategies that should be considered (see Rosston et al., 2010).

5. Discussion and conclusions

In this study they analyze tariffs for fixed broadband services in LAC, benchmarking price and quality levels against the OECD and estimating the effect of prices on penetration levels in the region. The results show that broadband services in LAC are generally expensive and of poor quality when benchmarked against the Organisation for Economic Co-operation and Development (OECD) countries, though significant variation exists within the region. Much of this variance exists between countries with similar economic and demographic characteristics, which suggests a significant potential for regulatory reforms to promote broadband adoption by strengthening market competition.

Their findings also reveal a relatively high own-price elasticity for fixed broadband demand in the LAC region, suggesting that policy initiatives aimed at reducing prices (such as Brazil's PNBL) could significantly increase adoption. The findings also suggest that a repressed demand exists, which cannot be addressed due to supply bottlenecks including lack of proper backhaul infrastructure outside large urban centers. Yet the findings also reveal that price reductions alone will likely not be enough, and that complementary demand-side policy initiatives will be needed in order for LAC countries to achieve adoption levels comparable to the OECD.

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References

Abdala, R., Oliveira, J., Kubota, L., & Wohlers, M. (2009). Banda larga no Brasil: Por que ainda não decolamos? *IPEA Radar*, *5*, 9–15.

Angrist, J., & Krueger, A. B. (2001). Instrumental variables and the search for identification: From supply and demand to natural experiments. *The Journal of Economic Perspectives*, *15*, 69–85.

Angrist, J., & Pischke, J. -S. (2008). *Mostly harmless econometrics: An empiricist's companion*. Princeton, NJ: Princeton University Press.

Cadman, R., & Dineen, C. (2008). *Price and income elasticity of demand for broadband subscriptions: A cross-sectional model of OECD countries*. London: SPC Network.

Cardona, M., Schwarz, A., Yurtoglu, B., & Zulehner, C. (2009). Demand estimation and market definition for broadband Internet services. *Journal of Regulatory Economics*, *35*, 70–95.

Chaudhuria, A., & Flamm, K. (2007). An analysis of the determinants of broadband access. *Telecommunications Policy*, *31*, 312–326.

Chinn, M., & Fairlie, R. (2010). Use in the developing world: An analysis of differences in computer and Internet penetration. *Review of International Economics*, *18*, 153–167.

Dattaa, A., & Agarwal, S. (2004). Telecommunications and economic growth: A panel data approach. *Applied Economics*, *36*, 1649–1654.

Drouard, J. (2011). Costs or gross benefits? What mainly drives cross-sectional variance in Internet adoption. *Information Economics and Policy*, *23*, 127–140.

ECLAC. (2011). *Panorama de la banda ancha en América Latina*. Santiago de Chile: ECLAC.

Ford, G., Koutsky, T., & Spiwak, L. (2007). *The broadband performance index: A policy-relevant method of comparing broadband adoption among countries*. Phoenix center policy paper no. 29. Phoenix Center for Advanced Legal and Economic Public Policy Studies.

Goldfarb, A., & Prince, J. (2008). Internet adoption and usage patterns are different: Implications for the digital divide. *Information Economics and Policy*, *20*, 2–15.

Greenstein, S., & McDevitt, R. (2010). Evidence of a modest price decline in US broadband services. *Information Economics and Policy*, *23*, 200–211.

Hauge, J., & Prieger, J. (2010). Demand-side programs to stimulate adoption of broadband: What works? *Review of Network Economics*, *9*, 4.

Horrigan, J. (2009). *Home broadband adoption 2009*. Washington D.C.: Pew Research Center.

infoDev. (2005). *Open access models: Options for improving backbone access in developing countries*. Washington D.C.: infoDev/World Bank.

Jordan, V., Galperin, H., & Peres, W. (2011). *Fast-tracking the digital revolution: Broadband for Latin America and the Caribbean*. Santiago de Chile: ECLAC.

Koutroumpis, P. (2009). Economic impact of broadband on growth: A simultaneous approach. *Telecommunications Policy*, *33*, 471–485.

Lie, E. (2007). International Internet interconnection: Next generation networks and development. *Presented at the 2007 ITU global symposium for regulators*. Dubai, UAE. February 5-7. Available at 〈http://www.itu.int/ITU-D/treg/Events/Seminars/GSR/GSR07/discussion_papers/Eric_lie_international_interconnection.pdf〉.

Macedo, H., & Carvalho, A. D. (2011). Broadband economic impact in Brazil: A simultaneous equation analysis. *Presented at the 5th ACORN-REDECOM conference*. Lima, Peru. Available at 〈http://www.itu.int/ITU-D/treg/Events/Seminars/GSR/GSR07/discussion_papers/Eric_lie_international_interconnection.pdf〉.

Močnik, D., & Širec, K. (2010). The determinants of Internet use controlling for income level: Cross-country empirical evidence. *Information Economics and Policy*, *22*, 243–256.

OECD. (2011). *Fibre access: Network developments in the OECD area*. OECD digital economy papers no. 182. OECD Publishing.

OFCOM. (2010a). The communications market 2010. London: OFCOM.

OFCOM. (2010b). Measuring mobile broadband in theUK. London: OFCOM.

Rappoport, P., Kridel, D., Taylor, L., & Alleman, J. (2002). Residential demand for access to the Internet. In G. Madden (Ed.), *The international handbook of telecommunications economics*, (Vol. II). Cheltenham: Edward Elgar Publishers.

Röller, L. -H., & Waverman, L. (2001). Telecommunications infrastructure and economic development: A simultaneous approach. *American Economic Review*, *91*, 909–923.

Rosston, G., Savage, S., & Waldman, D. (2010). Household demand for broadband Internet in 2010. *The B.E. Journal of Economic Analysis and Policy (Advances)*, *10* [article 79].

Wallsten, S. (2005). Regulation and Internet use in developing countries. *Economic Development and Cultural Change*, *53*, 501–523.

Ware, H., & Dippon, C. (2010). Wholesale unbundling and intermodal competition. *Telecommunications Policy*, *34*, 54–64.