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Socioeconomic Impact of Broadband in Latin American and Caribbean Countries

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Abstract*

Broadband plays a key role in society, impacting GDP, productivity, and employment. In the Latin American and Caribbean region, which is characterized by low broadband penetration costly Internet connection, low usage, and sporadic adoption of mobile technology, a major goal for governments is to universalize access to and usage of broadband. This paper presents an econometric model which shows that, in Latin America and the Caribbean, on average, a 10 percent higher broadband penetration is associated with 3.19 percent higher GDP, 2.61 percent higher productivity, and 67,016 new jobs. It also defines the variables that a government can control to help increase the number of broadband subscriptions per capita in order to effectively improve socioeconomic conditions in the country.

JEL Classifications: C52

Keywords: Broadband, LAC, Impact, GDP, Productivity, Employment

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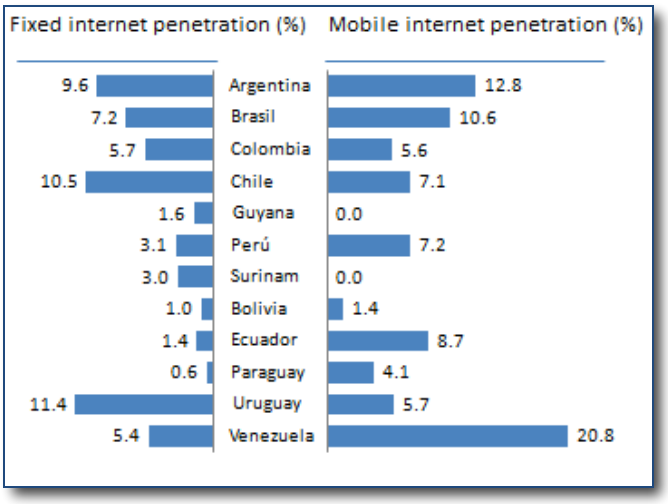
Introduction

Broadband Penetration in Latin America and the Caribbean

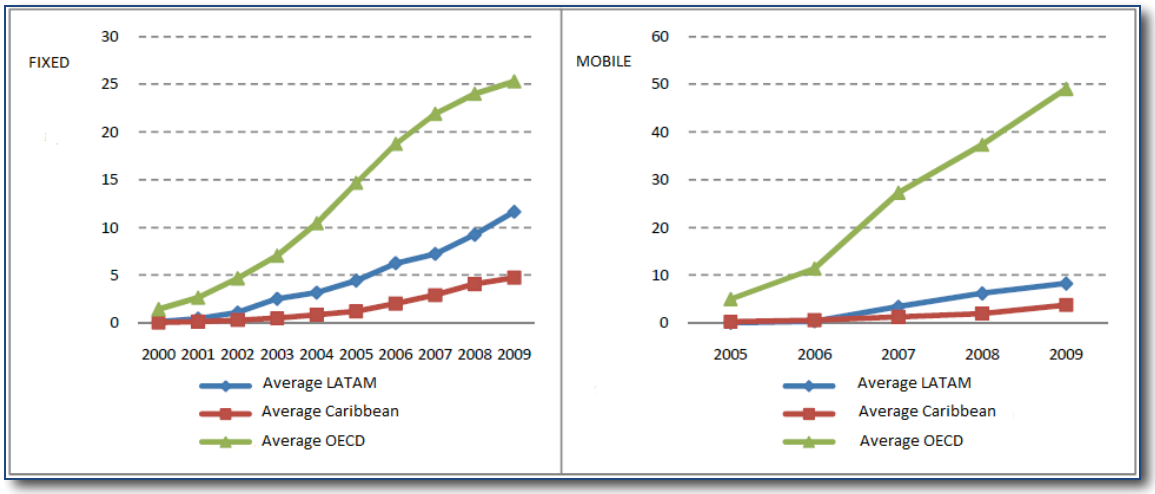
Fixed and mobile broadband penetration in Latin American and Caribbean (LAC) countries is much lower than in more industrialized countries, such as the OECD countries. In addition to being low, broadband penetration in LAC countries is quite unequal, as can be seen in Figure 1. The main reasons for this inequality are the variations in socioeconomic and orographic conditions in LAC countries and the high cost of the investments required for infrastructure (Czernich et al., 2009). However, and despite the moderate broadband penetration in LAC countries, mobile broadband has evolved very rapidly in recent years (see Figure 2).

Figure 1. Inequality of Broadband Penetration in LAC Countries



Source: ITU (2011).

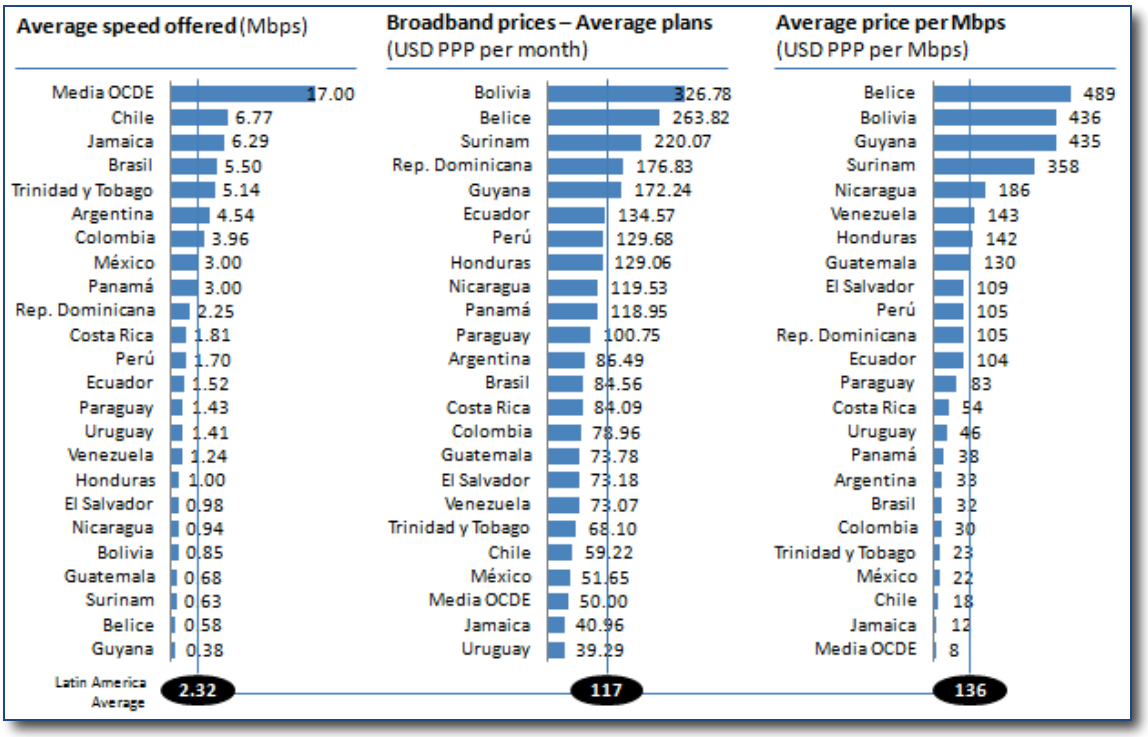
Figure 2. Fixed and Mobile Broadband Penetration in LAC and OECD Countries



Source: ITU (2011)

Indeed, Internet penetration in LAC countries has tended to favor mobile and, if mobile Internet penetration maintains the rate of growth seen in recent years, the number of mobile subscriptions is expected to reach twice the number of fixed subscriptions by 2012–2013 (Czernich, et al., 2009: ITU, 2011). Additionally, as shown in Figure 3, compared to the OECD, connectivity in the LAC region is not only low speed, but also considerably more costly (Garcia-Zaballos and Arias, 2009). These factors make it very difficult to close the existing technology gap.

Figure 3. Broadband Quality and Prices, LAC and OECD Countries



Source: Galperin and Ruzzier (2011).

Contributions to the Literature

The impact of telecommunications, specifically the Internet and broadband, on countries' socioeconomic development has already been proven by numerous studies, all of which concur that increases in broadband penetration have associated increases in GDP, productivity, and employment. However, these studies do not refer to LAC countries specifically, nor do they take a non-linear approach, as we do herein. Notwithstanding, our findings are constrained by the fact that the available information concerning broadband in the region is relatively recent.

This paper makes two major contributions to the literature: the first is an econometric model specific to LAC countries. This model demonstrates that, on average, countries that increase broadband penetration by 10 percent have associated increases of 3.19 percent in GDP and 2.61 percent in productivity, and generate 67,016 new jobs. A complementary finding is that the higher the broadband penetration rate, the greater the multiplier effect of an additional increase of broadband on GDP, productivity, and employment. The second contribution is the definition of a model that can help governments determine the means available to them to shape the broadband status of their respective countries.

Association of Broadband with GDP, Productivity, and Employment

Broadband and GDP

Our model consists of a time series pool cross section, with data from 26 LAC countries, analyzed year over year from 2003 to 2009. It shows that, in our sample, a 10 percent increase in broadband penetration brought about an average increase of 3.19 percent in per capita GDP. In other words, we determined the function that best fit the available dataset and measured, at the end of the timeframe considered,[1] the correlation between a 10 percent increase in broadband penetration and per capita GDP.

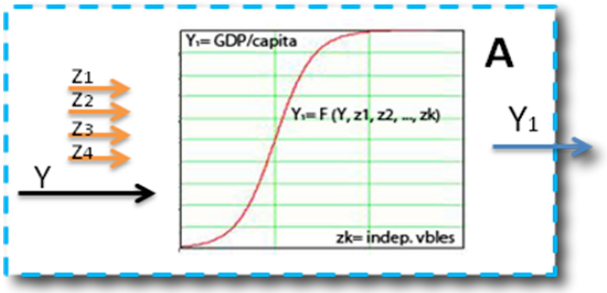
The reason we worked with a wealth model (GDP per capita and broadband penetration) rather than a growth model, which measures the immediate effect on GDP growth of an increase in broadband penetration in a given moment in time, is that we wanted to measure the long-term, cumulative effect associated with increases in broadband penetration over time, in this case, from 2003 to 2009.

GDP is a function of investment, consumption, public spending, and trade surplus or deficit. To determine the independent variables of the model, we chose 87 surrogate variables associated with these concepts that were not correlated to each other, and we selected those that provided the best model in terms of robustness (maximum self-determination coefficient, minimum coefficient of variation of residuals, and conditions of non-heteroskedasticity, non-autocorrelation, and non-multicolinearity). These five variables define the most appropriate model (see Figure 4), preserving robustness not just for one point in time but for several time periods (2003–2005, 2003–2007, and 2003–2009).

[1] Since we worked with a non-linear model, we analyzed the impact of broadband at the end of the chosen timeframe, that is, in 2009.

The formulation of a non-linear model is key and salient point of differentiation with current models. The reason for this choice is that the relationship between the explanatory variables and the dependent variable is non-linear. We verified this first by formulating a linear model for GDP[2] whose explanatory power (R^2) and coefficient of variation were considerably more limited than those of its equivalent non-linear model, and second, by verifying that scatter plots of residuals versus some of the independent variables presented a quadratic pattern. We relied on data used by the World Bank and the ITU. Specifically, our samples of regression variables come from the World Bank's World Development Indicators and ITU's World ICT Indicators databases.

Figure 4. Regression Model Vignette[3]



As can be seen in Figure 5, the independent variables are: fixed broadband penetration per 100 inhabitants (Y), the interest rate spread (Z1), the interest on new debt (Z2), the multilateral debt (Z3) and net official development aid (Z4), all of which are significant. All of these Z variables have a direct effect on investment and public spending in any given country, although some of them, such as Z3 and Z4, apply in a greater way to poorer countries. We study fixed broadband penetration instead of other variables such as mobile broadband penetration, broadband speed, or broadband coverage, due to the lack of data available for LAC countries in the period under consideration. However, despite the lack of information to analyze the effect of broadband speed on GDP in LAC, existing literature points out that the higher the broadband speed, the higher its effect on GDP. A report by Ericsson and Arthur D. Little in 33 OECD countries quantifies the isolated effect of broadband speed, showing that doubling the broadband speed for an economy increases GDP by 0.3 percent (Ericsson and Arthur D. Little, 2011.)

[2] We performed the same analysis for productivity and employment with exactly the same findings.
[3] The authors elaborated this figure, as well as and the remaining figures in this document.

Figure 5. Model Statistics

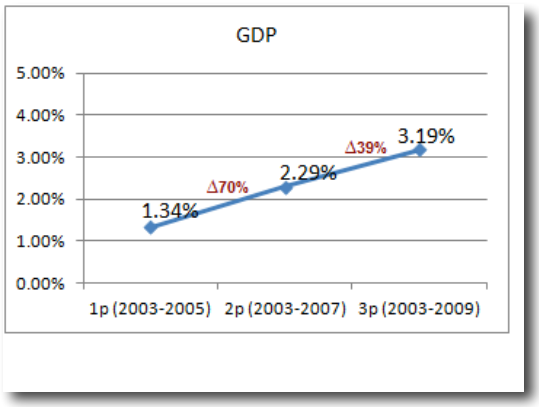
$Y1^{0.6} = 193 - 0.891\ Z_1 + 4.32\ Z_2 - 1.06\ Z_3 - 573\ Z_4 + 20.8\ Y - 0.872\ Y\text{-sq.}$

Predictor	Coef	T	
Constant	193.48	16.69	(*)
Z_1-Interest Rate Spread	-0.8912	-3.45	(*)
Z_2-Interest on New Debt	4.322	3.27	(*)
Z_3-Multilateral Debt	-1.0574	-5.07	(*)
Z_4-Net ODA/GDP PPP	-572.7	-4.04	(*)
Y-Broadband Penetration/100inh	20.817	6.94	(*)
Y-sq.	-0.8718	-2.72	(***)

(*) 99% (**) 95% (***) 90%

Our model, tested in different timeframes, posits that, on average, a 10 percent increase in broadband penetration in 2005 was associated with a 1.34 percent increase in GDP; in 2007, with a 2.29 percent increase; and in 2009, with a 3.19 percent increase. These findings corroborate that the greater the number of broadband subscriptions per capita a country has over time, the greater impact that an additional increase in the number of broadband subscriptions will have on that country's GDP. However, the pace of GDP growth decreases over time, which implies that the impact of broadband on GDP will reach a saturation point at some point in time (see Figure 6).

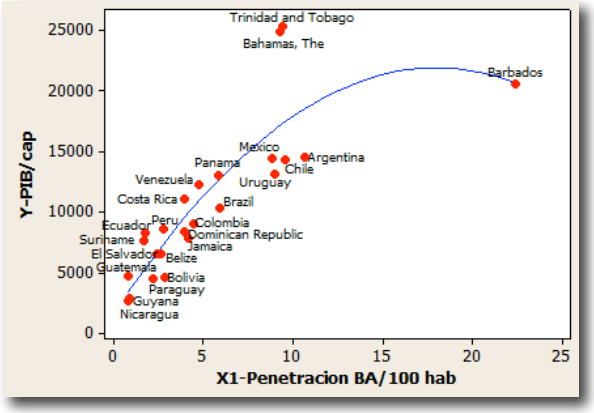
Figure 6. Impact on GDP Over time of a 10 Percent Increase in Broadband Penetration



Otherwise, as shown in Figure 7, among LAC countries, for a given timeframe, the relationship between broadband penetration and GDP per capita is quadratic but dampened over time, showing that (looking at the slope of the fitting curve at different penetration rates), when broadband penetration increases, GDP in poorer countries (those with fewer

broadband subscriptions) increases more than in wealthier countries (those with more broadband subscriptions).

Figure 7. Impact of Broadband on GDP among LAC Countries (2009)



Since our dataset contains only 121 samples for the seven years considered, we included other 36 additional countries, with similar GDP per capita to LAC countries, expanding the dataset to a total of 374 samples in the seven years in order to test for robustness. Using the same independent variables, our findings are exactly the same. Interestingly, on average, increases of 10 percent in broadband penetration have associated increases of 3.19 percent in GDP per capita. Given the nature of our data, we also controlled for country and year fixed effects and we observed similar findings and the same growth trend of GDP per capita versus broadband penetration.

Broadband and Productivity

As we did for broadband and GDP, we followed the same methodology to prove up to 92 variables associated with production inputs. As can be seen in Figure 8, the independent variables are: fixed broadband penetration per 100 inhabitants (Y), the Gini coefficient (Z1'), the ILO 131 minimum wage fixing convention (Z2'), the percentage of urban population (Z3'), the percentage of primary school enrollment (Z4'), and the percentage of primary school completed for students 15 years of age or older (Z5'), all of which are significant. While Z1' and Z3' are associated with geographic distribution of production inputs, Z2', Z4' and Z5' are associated with the quality of the labor force, which is influenced by the regulatory environment, wages, and education received, among other factors.

Figure 8. Model Statistics

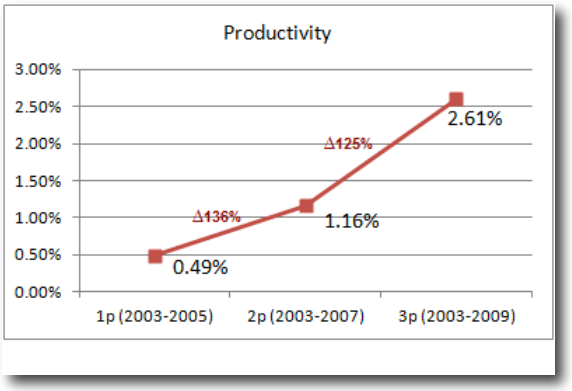
$Y_2^{0.5} = 236 - 1.31\ Z_1' - 11.3\ Z_2' + 0.422\ Z_3' - 0.758\ Z_4' + 0.883\ Z_5' + 3.93\ Y$

Predictor	Coef	T	
Constant	236.12	11.36	(*)
Z_1'-Gini	-1.3075	-3.25	(*)
Z_2'-ILO 131	-11.260	-3.73	(*)
Z_3'-Pop urban (%)	0.4216	2.26	(**)
Z_4'-Primary school enrolment (%)	-0.7581	-3.03	(*)
Z_5'-Age15+Primary completed (%)	0.8833	5.38	(*)
Y-Broadband Penetration/100inh	3.9286	4.88	(*)

(*) 99% (**) 95% (***) 90%

In this case, the model posits that, for LAC countries, on average, a 10 percent increase in broadband subscriptions per capita (see Figure 9) in 2004 was associated with a 0.49 percent increase in productivity; in 2006, with a 1.16 percent increase; and in 2008, with a 2.61 percent increase. These findings once again corroborate that the greater the number of broadband subscriptions per capita a country has over time, the more that an additional increase in the number of broadband subscriptions will impact a country's productivity. Additionally, and although similarly to GDP, the trend for productivity growth decreases over time, we note that productivity grows at a faster pace than GDP as the number of broadband subscriptions increases.

Figure 9. Impact on Productivity over Time of a 10 Percent Increase in Broadband Penetration



Finally, according to the model presented, policies whose goal is to decrease inequality are associated with an increase in productivity for any given country. Therefore, policies focused on inclusion, which consider aggregating demand in municipalities (healthcare centers, police and fire departments, agricultural cooperatives, and so on), will have an associated increase in productivity. Similarly, policies focused on quality (broadband speed)

will have a positive effect on productivity since, as mentioned above, greater broadband speed increases output (GDP) and, consequently, ceteris paribus, if inputs remain constant, productivity rises.

Broadband and Employment

We followed the same methodology as we did for broadband and GDP and for broadband and productivity, proving up to 89 variables to finally select the seven explanatory ones. As can be seen in Figure 10, the independent variables are: fixed broadband penetration per 100 inhabitants (Y), the number of days needed to start a business indicator (Z1''), the percentage of the population age 15 or older (Z2''), the interest rate (Z3''), the cost of start-up procedures (Z4''), new business density (Z5''), new business density squared (Z5'' sq.), and the value-added of the industrial sector as a percentage of GDP (Z6''), all of which are significant. While Z1'', Z3'', Z4'', and Z5'' are associated with the conditions to generate new employment, Z2'' relates to the working-age population and Z6'' to the importance of the industrial sector in the economy.

Figure 10. Model Statistics

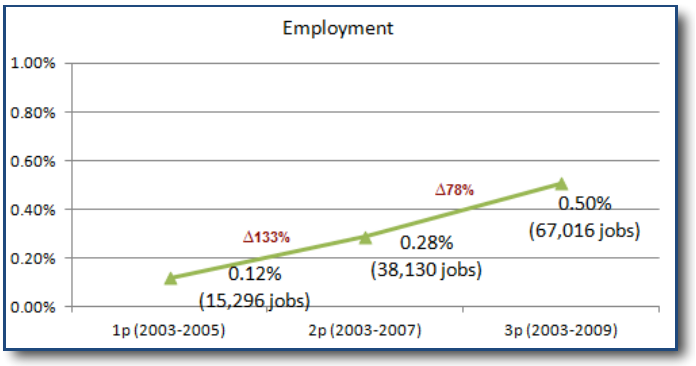
$$1/Y_3 = 0.00973 + 0.000009\ Z_1'' + 0.000102\ Z_2'' - 0.000083\ Z_3'' - 0.000015\ Z_4'' + 0.000269\ Z_5'' - 0.000023\ Z_5''\text{-sq.} + 0.000032\ Z_6'' - 0.000154\ Y$$

Predictor	Coef	T	
Constant	0.00973	5.55	(*)
Z_1''-DaysToStartBusiness	0.000009	10.50	(*)
Z_2''-Population 15+ (%)	0.000102	3.83	(*)
Z_3''-Interest Rate	-0.000083	-9.16	(*)
Z_4''-Cost start-up procs. (%GNI)	-0.000015	-4.72	(*)
Z_5''-New business density (per th.)	0.000269	2.03	(**)
Z_5''-sq.	-0.000023	-2.19	(**)
Z_6''-Industry, value added (%GDP)	0.000032	2.09	(**)
Y-Broadband Penetration/100inh	-0.000154	-3.09	(*)

(*)99% (**)95% (***)90%

In this case, the model posits that for LAC countries, on average, a 10 percent increase in broadband subscriptions per capita (see Figure 11) in 2005 was associated, with 15,296 new jobs created (0.12 percent more jobs); in 2007, with 38,130 new jobs (0.28 percent more jobs); and in 2009, with 67,016 new jobs (0.5 percent more jobs). These findings once again corroborate that the higher the number of broadband subscriptions per capita in a country over time, the more that an additional increase in the number of broadband subscriptions will impact a country's employment level.

Figure 11. Impact on Employment over Time of a 10 Percent Increase in Broadband Penetration

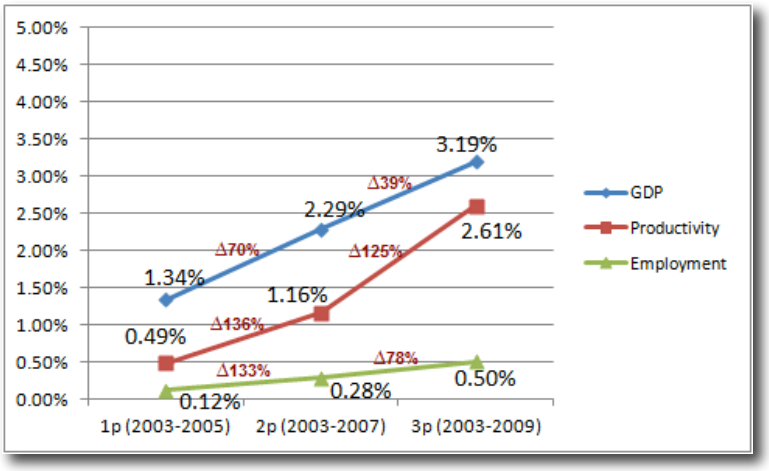


Broadband Network Economies Effect

As we have analyzed throughout this chapter, since broadband is a crosscutting service enabler with clear socioeconomic benefits, it is imperative for governments to intervene proactively to effectively accelerate broadband penetration in the LAC region.

As we have already presented for GDP, productivity, and employment, and as Figure 12 illustrates, the models verify the existence of a broadband network economies effect and thus, the more broadband subscriptions a country has over time, the greater the impact of an additional increase in the number of broadband subscriptions on GDP, productivity, and employment. This leads to the conclusion that the more maintainable the broadband policy of a country is, the better this policy will be for the country.

Figure 12. Impact on GDP, Employment, and Productivity over Time of a 10 Percent Increase in Broadband Penetration



But these findings are not sufficient. The question remains how governments can increase broadband subscriptions by 10 percent. To solve this dilemma, we move on to the last contribution of the paper, which addresses the variables that a government can effectively control to help shape broadband policy in the country.

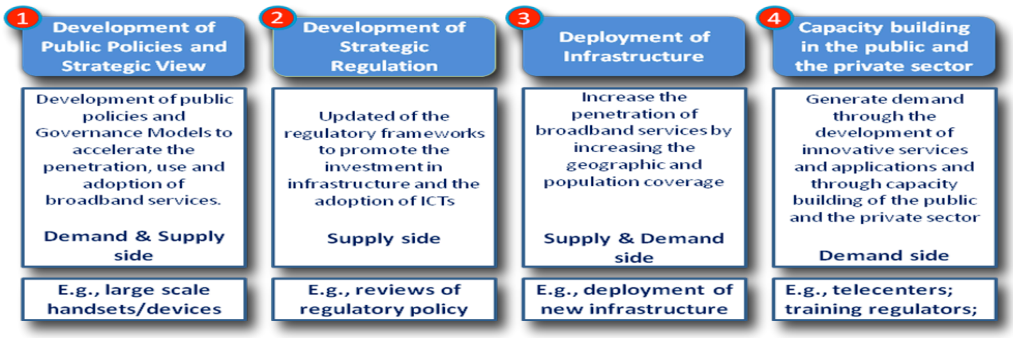
Levers to Determine a Country's Broadband Policy

In this section, we focus on the econometric model that defines the variables that will help a government to effectively increase the number of broadband subscriptions per capita in order to improve the socioeconomic conditions of the country.

Econometric Model to Shape a Country's Broadband Status

Technology becomes cheaper over time. As a result, broadband penetration is expected to experience vegetative growth. However, there is no theoretical model in the literature that explains broadband penetration for a given country. At the Inter-American Development Bank, broadband penetration in LAC is explained in terms of four pillars: 1) public policies and strategic vision; 2) strategic regulation; 3) ICT infrastructure; and 4) capacity building and applications (see Figure 13).

Figure 13. The Four Pillars that Explain Broadband Penetration



These pillars will be the basis for defining an econometric model that is new in the literature. We formulate a non-linear multivariate regression model using data from the World Bank and the ITU, where the dependent variable is the number of fixed broadband subscriptions per 100 inhabitants (Y) and, after proving up to 105 different variables associated with the four pillars presented, we chose seven independent variables: the number

of cellular subscriptions (X1), the percentage of the population between 15 and 65 years of age (X2), the percentage of households with PCs (X3), the monthly cost per business of a fixed telephone line (X4), the existence of IP telephone regulations (X5), the ending age of compulsory education (X6), and the time it takes to start a business (X7), all of which are significant (see Figure 14).

Figure 14. Model Statistics

$$\sqrt{Y} = -4.08 + 0.00951\,X_1 + 0.0532\,X_2 + 0.0327\,X_3 + 0.0129\,X_4 - 0.295\,X_5 + 0.0628\,X_6 - 0.00116\,X_7$$

Predictor	Coef	T	
Constant	-4.08	-5.87	(*)
X_1-Cellulars/100 inh.	0.00951	7.99	(*)
X_2-Population age 15-64	0.0532	4.13	(*)
X_3-Households % with PC	0.0327	7.37	(*)
X_4-Monthly $/business telephone service	0.0129	2.49	(**)
X_5-IP telephony regulations?	-0.295	-3.34	(*)
X_6-Ending age of compulsory education	0.0628	2.77	(*)
X_7-Time to start a business	-0.00116	-3.65	(*)

(*)99% (**)95% (***)90%

Apart from these seven variables, one of which is exogenous (X2) and not directly controlled by the government and another one (X1) that has achieved almost a saturation point by 2012,[4] we observed other variables that according to international evidence (Yongsoo, et al., 2010; OECD, 2011; Jordan, et al., 2011) play a key role in broadband penetration. However, they have not been included in the analysis because data are not available. These are X1', spectrum management; X2', interconnection issues; X3', tariff affordability policies; X4', Infrastructure sharing; X5', access and infrastructure market competitiveness; X6', regulation for the inclusion of ICTs in infrastructure; X7', Effective use and endowment of a broadband universal access fund; X8', percentage of population with IT knowledge; X9', number of innovation centers and tele-centers per country; X10', number of universities that include IT for teaching purposes; and X11', number of software applications generated per country.

Once we have the regression model, we can analyze the weight of every independent variable in explaining the dependent variable by looking at the T_{obs} statistic. If we do this, we have the weights shown in Figure 15.

[4] We predict a substitution effect among voice mobile subscriptions and data mobile subscriptions. In our model, we used the total number of mobile subscriptions instead of the total number of data mobile subscriptions because there was not enough information available on data mobile subscriptions in the period considered (2003–2009).

Figure 15. Relative Weight of Explanatory Variables

Key Variable	$\|T_{obs}\|$	Weight
X1- Cellular subscriptions	7.99	* * * * * * *
X2- Population 15-64 years	4.13	* * * * *
X3- Households % with PC	7.37	* * * * * *
X4- Monthly $/business line	2.49	*
X5- IP telephone regulations	3.34	* * *
X6- Ending age of compulsory education	2.77	* *
X7- Time to start a business	3.65	* * * *

Findings of the Model

The relationship between the explanatory variables and the dependent variable is not one of direct causation. However, it is still a strong and not hazardous relationship, as we have shown for different time periods (2003–2005, 2003–2007, and 2003–2009), where the model has always preserved its validity and robustness. In Figure 16.a, we summarize the variables that prove to be significant in our model, classified by supply/demand and by dimension/pillar, and in Figure 16.b, we summarize the variables that are also relevant for broadband penetration purposes but for which no data are available.

Figure 16a. Summary of Measurable Significant Variables

X_i	Key Variable	End/Ex.	Weight	Supply/Demand	Pillar	Pillar Description	Pillar weight
X_1	Cellular Subscriptions	Endog.	*******	Supply/Demand	1 – 3	P1: Public Policy and Strategic View	***
X_3	Households % with PC	Endog.	******	Supply/Demand		P3: ICT infrastructure	***
X_7	Time to Start a Business	Endog.	****	Supply	2	P2: Strategic Regulation	**
X_5	IP telephone regulations	Endog.	***	Supply			
X_4	Monthly$/business phone line	Endog.	*	Supply			
X_6	Ending Age Compulsory Education	Endog.	**	Demand	4	P4: Capacity Building	*
X_2	Population 15-64 years	Exog.	*****	—	—	—	—

Figure 16b. Summary of Non-measurable Relevant Variables

Xi'	Key Variables
X1'	Spectrum Management
X2'	Interconnection Issues
X3'	Tariffs Affordability Policies
X4'	Infrastructure Sharing
X5'	Access' and Infrastructure's Market Competitiveness
X6'	Regulation for the Inclusion of ICTs in Infrastructures
X7'	Effective Use and Endowment of a Broadband Universal Access Fund
X8'	Percentage of Population with IT Knowledge
X9'	Number of Innovation Centers and Tele-Centers per Country
X10'	Number of Universities that include IT for Teaching Purposes
X11'	Number of SW Applications generated per Country

Considerations about the Model

The econometric model presented in this publication to explain the fixed number of broadband subscriptions per 100 inhabitants of a country is subject to the existing data that, as previously mentioned, are scarce. Consequently, and although variables associated with Public Policy and Strategic View and ICT Infrastructure seem to have played a more important role in determining the broadband status of any LAC country in the past few years (Figure 16b), we could expect a greater importance than the one presented by our model for other variables associated with strategic regulation or capacity building and applications. Despite the constraints in data availability, our findings show that, according to the weights of Figure 15, there seems to have been a relative lack of governmental support for strategic regulation and capacity building for LAC countries.

Otherwise, according to the World Bank (Youngsoo, 2010) and the OECD (OECD, 2004), strategic regulation and capacity building policies have proven to be essential to reducing the digital divide (incidentally, the countries at the top of the OECD broadband ranking have promoted capacity building initiatives more proactively than the others in the last few years). Consequently, it is clear that it is time for LAC governments to prioritize and redirect more efforts to capacity building and application development initiatives.

Conclusions

Governments in Latin America and the Caribbean can improve the broadband status of their respective countries by controlling some key variables. As shown in this paper, although some of these variables can be directly measured and their significance analytically proven, other variables are not easily measured, even though they are internationally recognized.

Of the measurable variables that we have identified in our model, those associated with public policies and strategic view and ICT infrastructure have played a key role in determining the broadband status of LAC countries in the past few years, showing the active role of governments on these fronts. This has underscored the need for a greater focus on strategic regulation and capacity building and applications. By generating additional broadband subscriptions, focusing on these pillars will have a larger effect on GDP, productivity, and employment. The results show that, in Latin America and the Caribbean, on average, a 10 percent higher broadband penetration is associated with 3.19 percent higher GDP, 2.61 percent higher productivity, and 67,016 new jobs.

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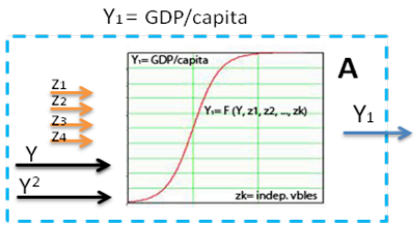
Technical Appendix

This technical appendix describes in greater detail the statistical models developed in this paper. Some robustness tests and key indicators are also presented.

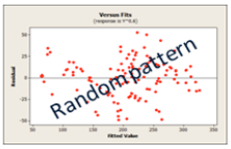
Broadband & GDP (only LAC)



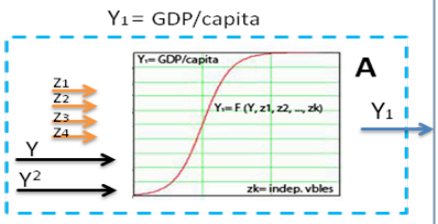
z_1= Interest Rate Spread
z_2= Interest on New Debt
z_3= Multilateral Debt
z_4= Net Official Development Assistance

Y= Broadband subscriptions/100 inhabitants

```
Non-Linear Multivariate Regression Equation
Y1^0.6 = 193 - 0.891 Z1 + 4.32 Z2 - 1.06 Z3 - 573 Z4 + 20.8 Y - 0.872 Y-sq.

Predictor                          Coef  SE Coef      T      P     VIF
Constant                         193.48    11.59  16.69  0.000
Z1-Interest Rate Spread         -0.8912   0.2586  -3.45  0.001   1.090
Z2-Interest on New Debt          4.322    1.323    3.27  0.001   1.910
Z3-Multilateral Debt            -1.0574   0.2087  -5.07  0.000   3.691
Z4-Net ODA/GDP PPP               -572.7    141.9  -4.04  0.000   2.531
Y-Broadband Penetration/100inh   20.817    2.999   6.94  0.000  12.936
Y-squared                       -0.8718   0.3200  -2.72  0.007  10.534

R-Sq = 89.8%   C.V.= 9.1783%   S = 21.9655   R-Sq(adj) = 89.2%
PRESS = 60561.3   R-Sq(pred) = 88.74%

ANOVA
Source           DF      SS     MS       F      P
Regression        6  482976  80496  166.84  0.000
Residual Error  114   55003    482
Total           120  537979

Source                          DF  Seq SS
Z1-Interest Rate Spread          1   30789
Z2-Interest on New Debt          1  146565
Z3-Multilateral Debt             1  214886
Y-Broadband Penetration/100inh   1   79153
Y-sq.                            1    3719
Z4-Net ODA/GDP PPP               1    7862

Durbin-Watson statistic = 2.41340
Arlinson-Darling Normality Test P-value= 0.201

Variable        N  N*  Mean  StDev  Variance  Minimum  Median  Maximum
Y-GDP/100inh  156   0  9225   6111  37348398      982    7760    26403

Correlation Matrix
          Z1       Z2       Z3        Y
Z2    -0.026
Z3     0.179   -0.600
Y     -0.218    0.113   -0.554
Z4     0.069   -0.608    0.730   -0.314
```



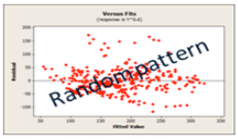
Broadband & GDP (LAC + 36 additional countries)



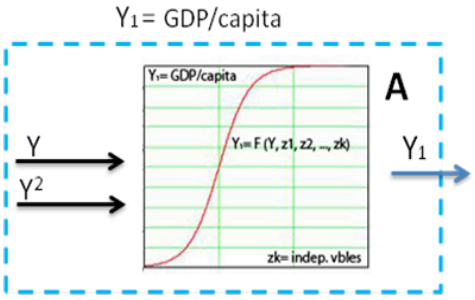
z_1= Interest Rate Spread
z_2= Interest on New Debt
z_3= Multilateral Debt
z_4= Net Official Development Assistance

Y= Broadband subscriptions/100 inhabitants

```
Non-Linear Multivariate Regression Equation
Y1^0.6 = 155 - 0.956 Z1' + 7.27 Z2'- 0.310 Z3' - 350 Z4'+ 21.2 Y - 0.689 Y-sq.

Predictor                          Coef   SE Coef      T      P
Constant                        154.717     9.729  15.90  0.000
Z1'-Interest Rate Spread        -0.9562    0.3321  -2.88  0.004
Z2'-Interest on New Debt          7.270     1.425   5.10  0.000
Z3'-Multilateral Debt            -0.3100   0.1528  -2.03  0.043
Z4'-Net ODA/GDP PPP              -350.13    84.90  -4.12  0.000
Y-Broadband Penetration/100inh    21.233    1.943  10.93  0.000
Y-sq.                            -0.6888   0.1274  -5.41  0.000

R-Sq = 62.2%   C.V.= 22.091%   S = 45.2712   R-Sq(adj) = 61.5%
PRESS = 739833   R-Sq(pred) = 58.68%

ANOVA
Predictor                          Coef   SE Coef      T      P     VIF
Constant                        154.717     9.729  15.90  0.000
Z1'-Interest Rate Spread        -0.9562    0.3321  -2.88  0.004   1.052
Z2'-Interest on New Debt          7.270     1.425   5.10  0.000   1.624
Z3'-Multilateral Debt            -0.3100   0.1528  -2.03  0.043   2.307
Z4'-Net ODA/GDP PPP              -350.13    84.90  -4.12  0.000   1.623
Y-Broadband Penetration/100inh    21.233    1.943  10.93  0.000   4.399
Y-sq.                            -0.6888   0.1274  -5.41  0.000   3.919

Source                          DF  Seq SS
Z1'-Interest Rate Spread         1   91800
Z2'-Interest on New Debt         1  429492
Z3'-Multilateral Debt            1  190507
Z4'-Net ODA/GDP PPP              1   34857
Y-Broadband Penetration/100inh   1  307577
Y-sq.                            1   59834

Durbin-Watson statistic = 2.049

Variable        N  N*  Mean  StDev  Variance  Minimum  Median  Maximum
Y1-GDP/100inh 372   0  7123   5351  28634223      857    5571    26403

Correlation Matrix
          Z1'      Z2'      Z3'        Y
Z2'    -0.117
Z3'    -0.184   -0.047
Y       0.627    0.311   -0.056
Z4'    -0.195    0.073    0.117    0.366
```



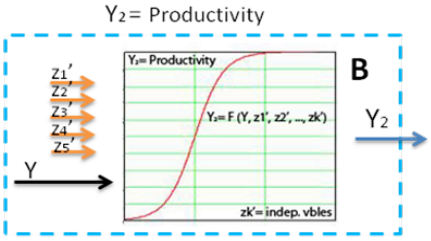
Broadband & GDP: Fixed effects (only LAC)



Y= Broadband subscriptions/100 inhabitants

```
Y-GDP/100inh = 9456 + 619 X-Broadband Penetration/100inh - 14.0 X-sq.
               - 67 X1-Argentina + 12754 X2-Bahamas + 4241 X3-Barbados
               - 4381 X4-Belize - 5983 X5-Bolivia - 2275 X6-Brazil
               + 148 X7-Chile - 2784 X8-Colombia - 741 X9-Costa Rica
               - 3543 X10-Dominican Republic - 2708 X11-Ecuador
               - 4285 X12-El Salvador - 5508 X13-Guatemala - 7222 X14-Guyana
               - 8646 X15-Haiti - 6189 X16-Hon - 3783 X17-Jamaica
               + 1808 X18-Mexico - 7440 X19-Nicaragua - 727 X20-Panama
               - 5912 X21-Paraguay - 3435 X22-Peru - 3401 X23-Suriname
               + 11509 X24-TrinidadsTobago - 905 X25-Uruguay - 331 Xt-2004
               + 43 Xt-2005 + 330 Xt-2006 + 553 Xt-2007 + 638 Xt-2008

Predictor                          Coef  SE Coef       T      P
Constant                         9455.7    350.6   26.97  0.000
X-Broadband Penetration/100inh    619.13    63.99    9.68  0.000
X-sq.                            -13.976    2.711   -5.16  0.000
X1-Argentina                      -66.9    341.4   -0.20  0.845
X2-Bahamas                       12754.0    354.4   35.99  0.000
X3-Barbados                       4241.0    654.7    6.48  0.000
X4-Belize                        -4381.4    317.4  -13.80  0.000
X5-Bolivia                       -5982.9    333.7  -17.93  0.000
X6-Brazil                        -2275.1    319.1   -7.13  0.000
X7-Chile                           148.2    364.2    0.41  0.685
X8-Colombia                      -2783.6    317.0   -8.78  0.000
X9-Costa Rica                     -740.8    317.6   -2.33  0.021
X10-Dominican Republic           -3542.9    319.1  -11.10  0.000
X11-Ecuador                      -2708.4    333.8   -8.11  0.000
X12-El Salvador                  -4284.7    323.4  -13.25  0.000
X13-Guatemala                    -5508.2    340.4  -16.18  0.000
X14-Guyana                       -7221.7    356.7  -20.24  0.000
X15-Haiti                        -8646.2    357.1  -24.21  0.000
X16-Hon                          -6189.0    357.1  -17.33  0.000
X17-Jamaica                      -3782.8    316.0  -11.97  0.000
X18-Mexico                        1807.9    324.7    5.57  0.000
X19-Nicaragua                    -7439.6    339.3  -21.93  0.000
X20-Panama                        -727.0    318.1   -2.29  0.024
X21-Paraguay                     -5912.3    331.7  -17.82  0.000
X22-Peru                         -3434.7    318.5  -10.78  0.000
X23-Suriname                     -3400.9    333.0  -10.21  0.000
X24-TrinidadsTobago              11508.8    318.0   36.19  0.000
X25-Uruguay                       -904.6    324.0   -2.79  0.006
Xt-2004                           -331.4    241.8   -1.37  0.173
Xt-2005                             43.3    226.7    0.19  0.849
Xt-2006                            329.6    204.2    1.61  0.109
Xt-2007                            553.3    179.9    3.08  0.003
Xt-2008                            638.0    164.3    3.88  0.000


S = 547.149   R-Sq = 99.4%   R-Sq(adj) = 99.2%

Analysis of Variance
Source           DF          SS          MS       F      P
Regression       32  5613269503  175414672  585.94  0.000
Residual Error  120    35924614     299372
Total           152  5649194117
```

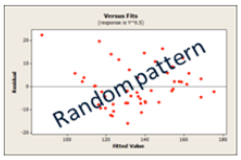
Broadband & Productivity



z_1' = Gini Coefficient
z_2' = ILO 131
z_3' = Urban Population (%)
z_4' = Primary School Enrolment (%)
z_5' = Age15+ Primary Completed (%)

Y= Broadband subscriptions/100 inhabitants

```
Non-Linear Multivariate Regression Equation
Y2^0.5 = 236 - 1.31 Z1' - 11.3 ILO Z2' + 0.422 Z3' - 0.758 Z4' + 0.883 Z5' + 3.93 Y

Predictor                          Coef  SE Coef      T      P    VIF
Constant                         236.12    20.78  11.36  0.000
Z1'-Gini                        -11.260    3.019  -3.73  0.001  1.268
Z2'-ILO 131                      0.4216   0.1869   2.26  0.029  1.299
Z3'-Pop urban (%)               -0.7581   0.2504  -3.03  0.004  2.254
Z4'-1ary school enrolment(%)     0.8833   0.1643   5.38  0.000  1.236
Z5'- Age15+Primary compl.(%) -1.3075   0.4017  -3.25  0.002  2.343
Y-Broadband Pen./100inh.         3.9286   0.8049   4.88  0.000  1.132

R-Sq = 82.2%    C.V.= 6.8023%    S = 9.41138    R-Sq(adj) = 79.7%
PRESS = 6031.68   R-Sq(pred) = 71.83%

ANOVA
Source           DF       SS      MS      F      P
Regression        6  17603.0  2933.8  33.12  0.000
Residual Error   43   3808.7    88.6
Total            49  21411.7

Source                                DF  Seq SS
Y-Broadband Penetration/100 inh.       1  3651.0
Z1'-Gini                               1  8232.1
Z2'-ILO 131                            1  1892.6
Z3'-Pop urban (%)                      1   924.2
Z4'-1ary school enrolment(%)           1   341.6
Z5'-Age15+Primary completed (%)        1  2561.6

Durbin-Watson statistic = 1.78832
Arlinson-Darling Normality Test P-value = 0.08

Variable         N  N*   Mean  StDev  Variance  Minimum  Median  Maximum
Y-Productivity  96  86  19148   9928  98566858     7015   16780    53012

Correlation Matrix
              Y       Z1'       Z2'       Z3'       Z4'
Z1'     -0.120
Z2'     -0.147    -0.117
Z3'      0.393    -0.184    -0.047
Z4'     -0.169     0.627     0.311    -0.056
Z5'     -0.197    -0.195     0.073     0.117     0.366
```



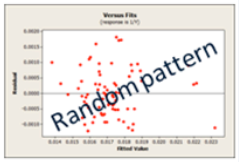
Broadband & Employment

Y_3 = Employment

Z_1'' = Days to Start a Business
z_2'' = Population 15+ (%)
z_3'' = Interest Rate
z_4'' = Cost Start-up Procs (%GNI)
z_5'' = New Business Density (‰)
z_6'' = Industry Value Added (%GDP)

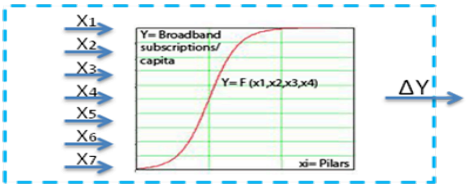
Y= Broadband subscriptions/100 inhabitants

```
Non-Linear Multivariate Regression Equation
1/Y3 = 0.00973 + 0.000009 Z1'' + 0.000102 Z2'' - 0.000083 Z3'' - 0.000015 Z4''
       + 0.000269 Z5'' - 0.000023 Z5''-sq. + 0.000032 Z6'' - 0.000154 Y

Predictor                                Coef     SE Coef      T      P     VIF
Constant                             0.009725    0.001751   5.55  0.000
Y-BB subscriptions/100 inh          -0.00015412  0.00004984 -3.09  0.003   1.867
Z1''-DaysToStartBus                  0.00000926  0.00000088 10.50  0.000   2.089
Z2''-Pop 15+(%)                      0.00010246  0.00002677  3.83  0.000   2.397
Z3''-Interest Rate                  -0.00008326  0.00000907 -9.18  0.000   1.185
Z4''-Cost start-up procs (%GNI)     -0.00001547  0.00000328 -4.72  0.000   2.646
Z5''-New biz density (per th)        0.0002690   0.0001327   2.03  0.047  17.836
Z5''-squared                        -0.00002315  0.00001057 -2.19  0.032  16.548
Z6''-Industry, value added (%GDP)    0.00003228  0.00001543  2.09  0.040   1.304

R-Sq = 82.1%    C.V.= 4.6812    R-Sq(adj) = 80.0%    S = 0.000789417
PRESS = 0.0000519721    R-Sq(pred) = 77.77%

ANOVA
Source           DF          SS           MS       F      P
Regression        8  0.000192062  0.000024008  38.52  0.000
Residual Error   67  0.000041753  0.000000623
Total            75  0.000233815

Source                                   DF      Seq SS
Y-BB subscriptions/100 inh                1  0.000000031
Z1''-DaysToStartBus                       1  0.000099075
Z2''-Pop 15+(%)                           1  0.000032801
Z3''-Interest Rate                        1  0.000043092
Z4''-Cost start-up procs (%GNI)           1  0.000012272
Z5''-New biz density (per th)             1  0.000000262
Z5''-sq.                                  1  0.000001802
Z6''-Industry, value added (%GDP)         1  0.000002729

Durbin-Watson statistic = 1.93151
Anderson-Darling Normality Test P-value = 0.124

Variable                  N  N*    Mean  StDev  Variance  Minimum  Median
Y-EmplToPop_Ratio,15+   156   0  59.300  5.186    26.894   44.300  59.050

Correlation Matrix
                      Y      Z1''     Z2''     Z3''     Z4''     Z5''
Z1''            -0.187
Z2''             0.697     0.038
Z3''             0.000     0.003   -0.020
Z4''            -0.487     0.410   -0.547   -0.048
Z5''            -0.016    -0.160    0.137    0.087   -0.299
Z6''            -0.120     0.183    0.211   -0.246   -0.140   -0.236
```



The 4 Pillars & Broadband

Y = Broadband subscriptions/100 inh.



X_1 = Cellular subscriptions/100 inh.
X_2 = Population Age 15-64 (%)
X_3 = Households with PC (%)
X_4 = Monthly $ per telephone business line
X_5 = IP telephony regulations (yes/no)
X_6 = Ending Age compulsory Education
X_7 = Days to Start a Business

```
Non-Linear Multivariate Regression Equation
√Y = -4.08+0.00951 X1+0.0532 X2+0.0327 X3+0.0129 X4-0.295 X5+0.0628 X6-0.00116 X7

Predictor                          Coef     SE Coef      T      P     VIF
Constant                        -4.0794      0.6950  -5.87  0.000
X1-cellulars/100 inh          0.009510    0.001190   7.99  0.000   1.395
X2-Pop.age 15-64               0.05317     0.01288   4.13  0.000   2.228
X3-Households% with PC        0.032660    0.004430   7.37  0.000   2.109
X4-Monthly$/bis teleph. service 0.012924  0.005197   2.49  0.015   1.371
X5-IP Telephony regulations?   -0.29460     0.08832  -3.34  0.001   1.340
X6-End.Age compulsory Education  0.06275   0.02262   2.77  0.007   1.266
X7-TimeToStartBus            -0.0011571  0.0003169  -3.65  0.000   1.218

R-Sq = 86.9%    C.V.= 23.3267%    R-Sq(adj) = 85.8%    S = 0.277009
PRESS = 7.81588    R-Sq(pred) = 83.92%

ANOVA
Source           DF       SS       MS      F      P
Regression        7  42.2298   6.0328  78.62  0.000
Residual Error   83   6.3689   0.0767
Total            90  48.5987

Source                                DF   Seq SS
X1-cellulars/100 inh                   1  23.3511
X2-Pop.age 15-64                       1  10.1161
X3-Households% with PC                 1   3.8339
X4-Monthly$/bis teleph. service        1   2.1019
X5-IP Telephony regulations?           1   0.5625
X6-End.Age compulsory Education        1   1.2412
X7-TimeToStartBus                      1   1.0231

Durbin-Watson statistic = 1.97978
Anderson-Darling Normality Test P-value = 0.391

Variable    N  N*    Mean  StDev  Variance  Minimum  Median  Maximum
sqr-Y     153   3  1.4102  0.9659    0.9330   0.0000  1.3105   4.7324

Correlation Matrix
       X1      X2      X3      X4      X5      X6
X2  0.410
X3  0.549   0.767
X4  0.287   0.485   0.364
X5 -0.004   0.275   0.415   0.121
X6  0.049   0.133   0.060   0.050   0.117
X7 -0.046   0.080  -0.008  -0.109  -0.112  -0.293
```