# Columbia Business School

Economic impact of broadband deployment in Ecuador

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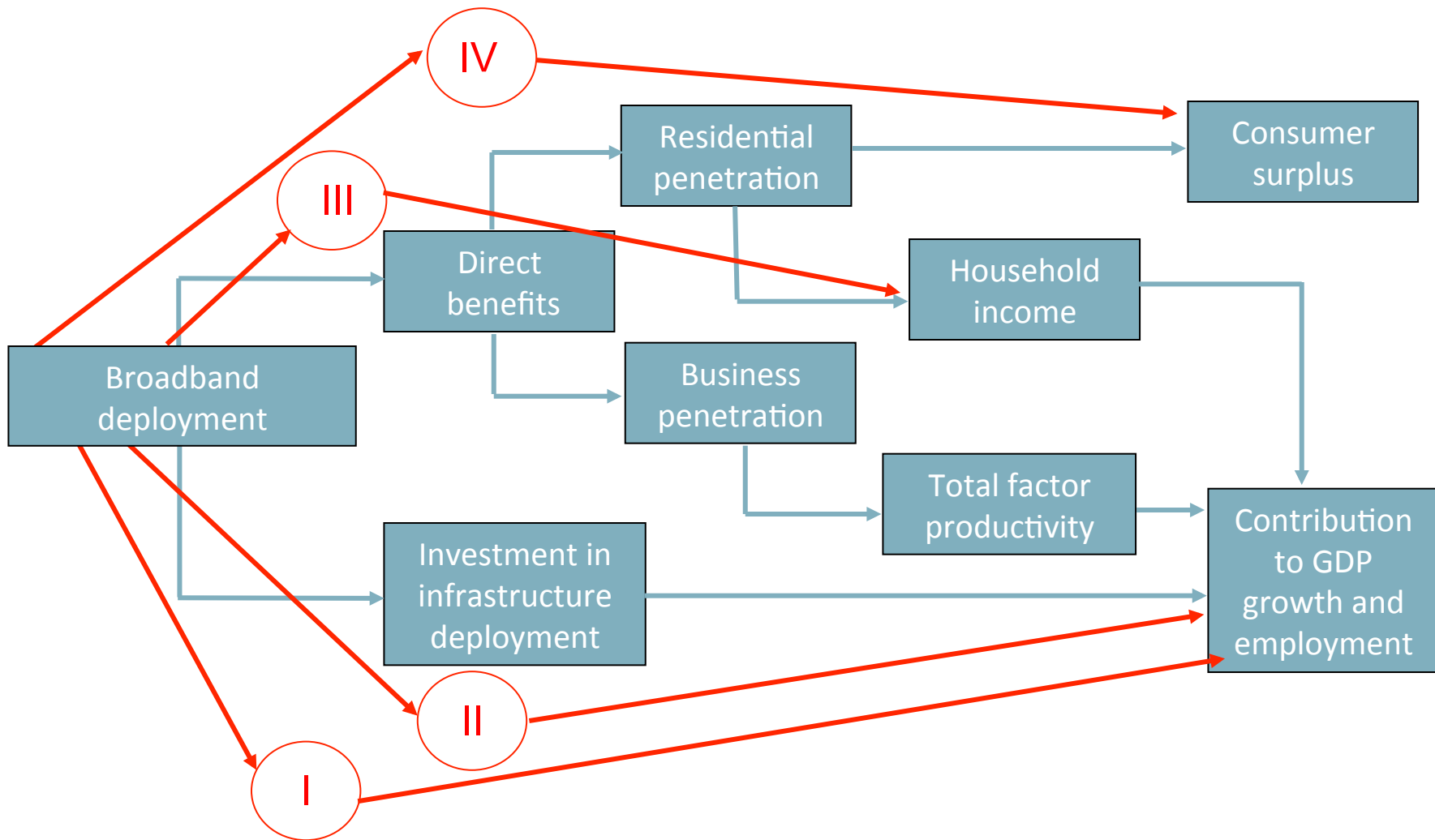
Until recently, most broadband economic impact analysis had been based primarily on aggregated economic data

- Studies like those of Crandall et al. (2007), Thompson and Garbacz (2008), Czernich et al. (2009), and Qiang et al. (2009) are based on samples of countries with data aggregated at the national or county level

- These efforts have limited control over possible effects of reverse causality, which have been partially addressed through structural models (Koutroumpis, 2009, Katz and Koutroumpis, 2012)

- In recent years, the implementation of national household surveys that now include ICT modules has allowed to research the impact of broadband based on *micro*-economic data

Microdata based studies are begining to confirm the results of aggregate data analysis

- DiMaggio y Bonikowski (2008) found a positive effect of internet usage on income, both at work and home, as a result of better skill signaling
- Navarro (2011) found a positive effect on average male income derived from Internet use in Brazil, Chile, Costa Rica, Honduras, México y Paraguay
- Using information from Peruvian households between 2007 and 2009, De Los Rios (2010) found that, during this time period, Internet adopters experienced significant income growth relative to those households that did not have the service
- Similarly, Atasoy (2011) analyzed the impact of expanding broadband access in the United States over the period of 1999-2007 and its impact on the job market, finding that access to broadband service had a positive impact on the employment rate

- The study is based on macroeconomic variables derived from information from the Ecuadorian Central Bank and the Institute of Statistics and Census of Ecuador

- It is also based on microdata derived from individual information from the National Household Survey conducted by the National Institute of Statistics and Census of Ecuador (INEC) between 2009 and 2011
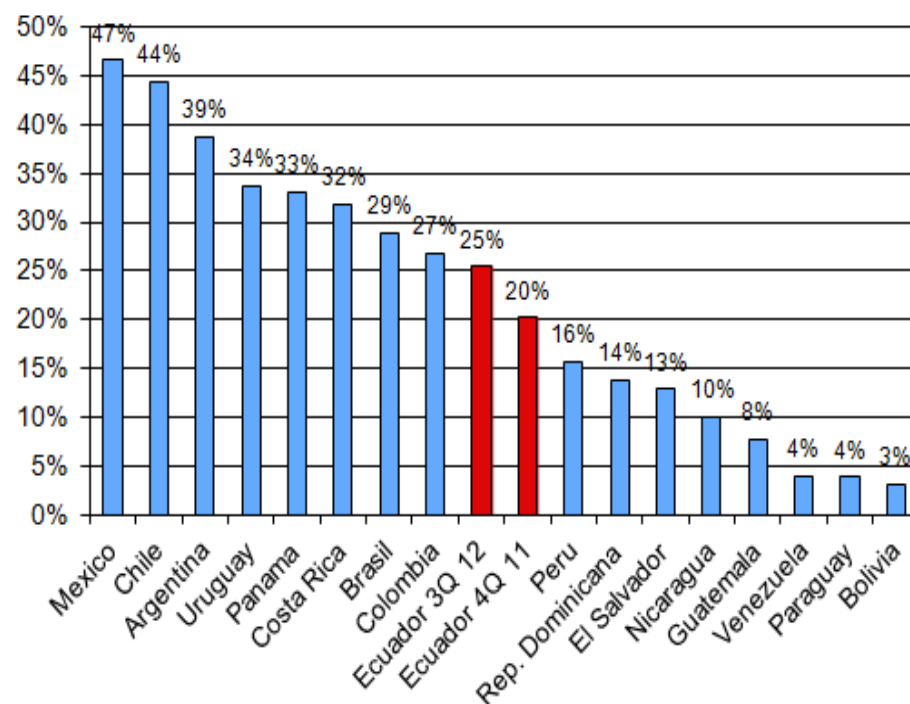
LATIN AMERICA: COMPARATIVE PENETRATION OF FIXED BROADBAND (2011)
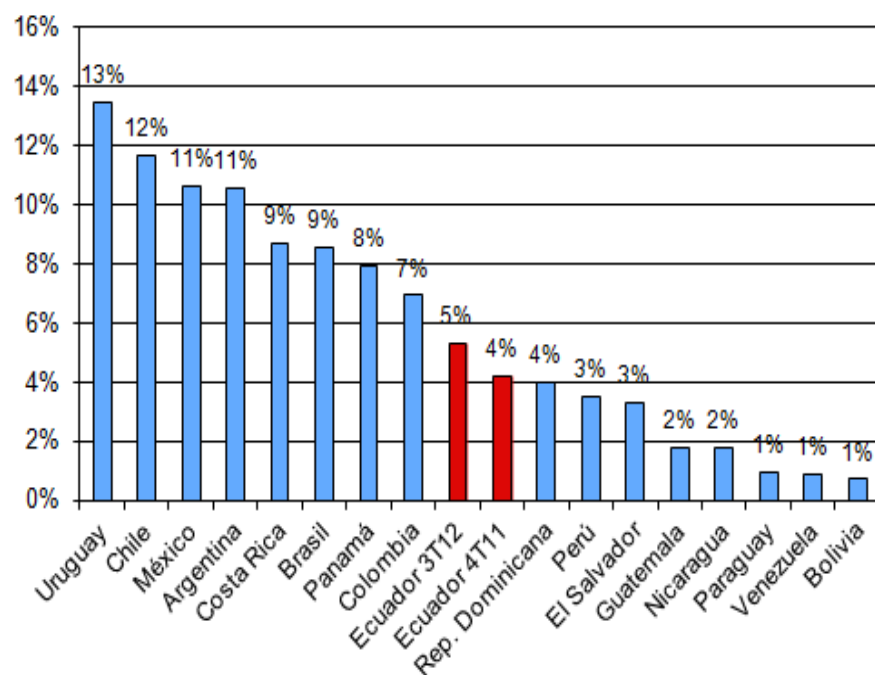
Sources: UIT; SENATEL; INEC; analysis by the authors

To test the economic impact of broadband, we initially built three models based on aggregate data

EFFECT	MODEL	LITERATURE
Contribution of ICT to GDP growth	• Structural model based on four equations (production function, demand, supply and output)	• Roller & Waverman (2001) (telephony) • Koutroumpis (2009) (broadband – OECD) • Katz & Koutroumpis (2012a) (wireless – Senegal) • Katz & Koutroumpis (2012b) (broadband - Philippines, Panama)
Impact on broadband on employment	• Model of impact on employment • Model of impact on unemployment	• Katz and Avila (2010) (broadband – Chile) • Katz and Callorda (2011) (broadband – Colombia)
Impact of broadband on average household income	• Model of impact on poverty • Model of impact on household income	• Katz (2011) (broadband – Costa Rica) • Katz and Callorda (2011) (broadband – Colombia)

The first structural model estimated the impact of broadband penetration growth on GDP, controlling for reverse causality

ECUADOR: IMPACT MODEL OF INCREASING BROADBAND PENETRATION ON GDP GROWTH

FUNCTION	EQUATION
Aggregate Production Function	$\Delta GDP_{it} = \alpha_1 \Delta\ Fixed\ Capital_{it} + \alpha_2 \Delta\ Labor\ Force_{it} + \alpha_3 \Delta\ Oil\ Price_{it}$ $+ \alpha_4 \Delta\ Broadband\ Penetration_{it} + \epsilon_{it} + Year\ Fixed\ Effect_t$
Demand function	$\Delta Broadband\ Penetration_{it}$ $= \alpha_1 \Delta\ Broadband\ Price_{it} + \alpha_2 \Delta\ Household\ Income_{it} + \epsilon_{it}$ $+ Year\ Fixed\ Effect_t$
Supply function	$\Delta Revenues\ of\ Broadband\ Companies_{it}$ $= \alpha_1 \Delta\ Household\ Income_{it} + \alpha_2 \Delta\ Urban\ Population_{it} + \epsilon_{it}$
Output function	$\Delta Broadband\ Penetration_{it} = \alpha_1 \Delta\ Revenues\ of\ Broadband\ Companies_{it} + \epsilon_{it}$

Model results estimate that 10% increase in broadband penetration growth contributes to 0.52% in GDP growth

ECUADOR: MODEL RESULTS ESTIMATING BROADBAND CONTRIBUTION TO GDP GROWTH

Function	Variables		Coefficients
GDP growth (PIBit)	Labor force (In L_{it})		0,300
	Fixed Capital Stock (In K_{it})		1,106
	Fixed Broadband Penetration (ln BB_Pen_{it})		0,052**
	Oil Prices (In Petróleo)		0,093 ***
	Constant		5,189
Demand (BB_Pen_{it})	Fixed Broadband Tariffs (BB_Pr_{it})		-0,347*
	Average Household Spending (ln_$Cons_{it}$)		6,555***
	Constant		-1,127
Supply (BB_$Ingresos_{it}$)	Average Household Spending (ln_$Cons_{it}$)		1,871
	Urbanization Rate (Urb_{it})		1,209***
	Constant		-1,127***
Output ΔBB_Pen_{it})	Broadband Revenues (BB_Rev_{it})		0,889***
	Constant		-18,143***
Yearly Fixed Effects			YES
Observations			17 (2T2008 – 2T2011)
R^2		Growth	99,75%
		Demand	98,75%
		Supply	99,60%
		Output	99,89 %

Source: Analisis by the authors

To estimate the impact of broadband using microdata, we calculated the impact of deployment on average income at the township level

- Until 2009 broadband supply outside main cities was very limited

- Between 2010 and 2011 CNT invested heavily in extending coverage to urban (and some rural) areas

- Opportunity for designing a quasi-experiment to compare changes in employment and income in:

    - Treatment group: townships connected in 2010-11 (27 townships with pop. 2.3M)

    - Control group: townships already connected in 2009 (10 townships with pop. 6.1M)

- Panel of individuals between 2009-2011 reporting labor income and ICT module:
  - Treatment group: 8,785 individuals
  - Control group: 7,664 individuals
- Sources: National Household survey and SENATEL
- Test of mean differences reveals groups have same distribution in variables of interest at baseline (2009)
- Key questions:
  - Does income raise more in townships connected in 2010-2011?
  - Are there differences between adopters and non adopters?
  - Are there heterogeneous effects (by age/gender/occupations)?

- The model utilized estimates the impact of treatment on the Y variable (individual income) as follows:

$$Y_i = \alpha + \gamma Tratamiento_i + \beta X_i + u_i + t_i + e_i$$

- Where i is each individual, Y is the dependent variable (income), γ estimates the causal impact of treatment (assuming the value of 1 if the individual was treated, 0 if it was not)
- X is a vector of control variables including age, genre, educational level, health coverage (as an indicator of belonging to formal economy), type of occupation and position in household
- u is a fixed effect by province where individual resides
- t is a yearly fixed effect
- e is the error term

The following results indicate the impact of broadband on an aveage monthly income of US$ 353.45

IMPACT ON MONTHLY INCOME

	US$ (Over two years)	Percent increase (over two years)	Annual increase
Increase in individual income for the total sample	US$ 25.76	7.48%	3.67%
Increase for individuals that already owned a computer	US$ 38.36	8.00%	3.92%
Increase for individuals that already were Internet users	US$ 51.86	10.27%	5.01%

While the overall effect is larger for men than for women, gender difference disappears if Internet was used before broadband had been adopted

Hypotheses for further research regarding the effects comprised in the treatment

- **Infrastructure construction**: Broadband deployment requires additional labor for infrastructure construction, operator's new commercial offices, and technical personnel for installation and maintenance
  - The new demand for labor in a market with an unemployment rate that is already below 5% generates a shift in the demand curve for workers, leading to an increase in equilibrium wages
  - The rise in wages through this channel may reflect a need for better compensation for those workers who, given the low unemployment rates, should receive better wages to meet or exceed their reservation wage
- **Improved labor productivity**: Classic labor economics literature shows that wages in competitive markets equal marginal productivity. As a result, higher labor productivity should yield higher wages
- **Skill "signaling"**: Research shows that the effect of broadband deployment is greater for computer and Internet users. Thus, the introduction of broadband allows workers with digital literacy skills to signal their computer knowledge to potential employers and then use those skills in the workplace in return for a higher wage
- **Reduced search costs**: the introduction of broadband can also help reduce the time required for an effective job search, leading to a reduction in unemployment periods and generating an increase in the migration of underemployed workers to full-time positions, which, in turn, results in higher labor income.