

THE IMPACT OF BROADBAND QUALITY STANDARDS ON INTERNET SERVICES MARKET STRUCTURE IN COLOMBIA

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- Telecommunications Regulatory Authority:
 - ▶ Objective: Guaranteeing adequate quality provision of Internet services to potential users.
 - ▶ How: Setting download/upload-speed standards.
 - ▶ Why:
 - ★ Reduce information asymmetry.
 - ★ Currently online activities require more bandwidth (Streaming music, video services and other applications).
- Colombia Regulatory Decision:
 - ▶ January 2008 - July 2010 → Broadband speed-level was defined as a download speed ≥ 512 kbps.
 - ▶ Since August → Broadband speed-level was defined as a download speed ≥ 1024 kbps.
- Regulatory succes: By the beginning of 2012, in Colombia 95 % of aggregate always-on Internet subscribers were connected to the net with a speed over the Broadband level.

- OECD(2014) has stated:
 - ▶ Colombia growth in per capita broadband subscriptions has lagged relative to OECD countries.
 - ▶ Colombia's fixed broadband speed is in the lowest range of OECD countries.
- Akamai's speed test:
 - ▶ 92 % of Colombia subscriptions belong to the lowest speed tier. (download speed < 4Mbps).

Purpose of the paper

- Analyze the role of Broadband-level standards in the structure and performance of Internet services markets.
- Provide explanation to the current conditions of the market.

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Theoretical Motivation

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- ▶ Differentiated product market: Quality attributes.
 - ★ Gabszewicz and Thisse (1979); Shaked and Sutton (1982)
 - ★ Berry (1994); Berry et al. (1995) → Products attributes as exogenous.
 - ★ Crawford et al. (2011); Fan (2011) → Product quality endogenous.
 - ★ Draganska et al. (2009) → Product varieties decision.

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 - ★ Draganska et al. (2009) → Product varieties decision.
 - ▶ Impact of MQS on vertical differentiation: Besank et al. (1987); Ronnen (1991) ; Crampes and Hollander (1995).
 - ▶ Quality and Variety: Economides (1993) → Substitution pattern between quality and varieties .
- By contrast, the objective of the paper is to measure the impact of Broadband quality labeling on product adoption and variety.

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- (Raw data) Contracts offered by every ISP, on a quarterly basis, between the last quarter of 2005 and the first quarter of 2012.
 - ▶ Municipality.
 - ▶ Segment.
 - ▶ Technology.
 - ▶ Download and Upload speeds.
 - ▶ Monthly-fee.
 - ▶ Effective Subscribers.

- (New data set) Aggregation of the detailed information of varieties in a representative contract for every municipality of the country so as to display information on:
 - ▶ Local penetration rate, $penetration_{i,t}$.
 - ▶ Weighted average monthly fee in USD, $p_{i,t}$.
 - ▶ Weighted average download speed, $s_{i,t}$.
 - ▶ Average number of varieties per ISP in each local market, $d_{i,t}$.
 - ▶ Technology diversity, $tec_{i,t}$.
 - ▶ Structural indicator of supply-side (HHI):
 - ★ Distribution of varieties among ISPs in local markets, $hhi_{1,i,t}$.
 - ★ Distribution of subscribers along varieties in local markets, $hhi_{2,i,t}$.
 - ★ Distribution of subscribers among ISPs in local markets, $hhi_{3,i,t}$.
 - ▶ Proxy of per capita income, $pc\ income$.

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The structural demand model

- Product differentiation:
 - ▶ Horizontal differentiation: Symmetric and asymmetric connections (varieties).
 - ▶ Vertical differentiation: Download speed-level.
- Our model constitutes an extension to Economides (1993) and Berry et al. (1995) since the order of moves for the choice of quality, variety and price is as follows:

Game Structure

- 1 ISP enter the local relevant market.
- 2 ISP commits to an aggregate quality level following the infrastructure investments.
- 3 ISP decides simultaneously on the variety differentiation variable together with price.

- Aggregate market level demand (log-log):

$$\begin{aligned} \text{penetration}_{i,t} = & \beta_1 p_{i,t} + \beta_2 d_{i,t} + \beta_3 \text{08-BL} + \beta_4 \text{10-BL} \\ & + \beta_5 X_{i,t} + \alpha_i + \alpha_t + \varepsilon_{i,t} \end{aligned} \quad (1)$$

- Empirical issues : Endogeneity and identification (Hausman, 1978).
- Solution: IV estimation for $p_{i,t}$ and $d_{i,t}$ endogenous variables.

$$p_{i,t} = \gamma_1 s_{i,t} + \gamma_2 \text{HHI}_{i,t} + \gamma_3 X_{i,t} + \delta_i + \delta_t + v_{i,t} \quad (2)$$

$$d_{i,t} = \phi_1 s_{i,t} + \phi_2 \text{HHI}_{i,t} + \phi_3 X_{i,t} + \psi_i + \psi_t + \zeta_{i,t} \quad (3)$$

4 The structural demand model

- Results

	Total Market (1)	<512Kbps (2)	≥512Kbps (3)	<1024Kbps (4)	≥1024Kbps (5)
<i>Panel C: Two-Stage Least Squares</i>					
<i>Dependent Variable: Always-on Internet Services Penetration</i>					
p	-0.809*** (0.0442)	-1.561*** (0.0704)	-1.156*** (0.0575)	-1.257*** (0.0586)	-1.153*** (0.114)
d	1.116*** (0.0326)	0.953*** (0.0512)	0.645*** (0.0445)	1.007*** (0.0405)	0.375*** (0.0845)
08-BL	0.241*** (0.0467)	-0.525*** (0.0576)	0.575*** (0.0941)	-0.203*** (0.0610)	1.507*** (0.185)
10-BL	0.119*** (0.0322)	-0.146*** (0.0485)	0.279*** (0.0454)	-0.334*** (0.0460)	0.604*** (0.0708)
pc income	0.0705** (0.0295)	0.0772 (0.0522)	0.0967* (0.0552)	0.133*** (0.0423)	-0.0427 (0.0825)
tec	1.105*** (0.0348)	1.022*** (0.0503)	0.964*** (0.0512)	0.906*** (0.0391)	0.907*** (0.0620)
Observations	14,169	13,116	8,212	13,906	5,744
R-squared	0.765	0.306	0.831	0.515	0.851
Municipalities	1,048	1,030	747	1,046	518
Fixed Effects	✓	✓	✓	✓	✓

Notes: Robust standard errors in parentheses. Observations and municipalities information is drawn from the unbalanced panel. Fixed Effects include period and municipality control variables. Sample period quarterly (when available) 2005q4-2012q1. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

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The contract varieties model

- Separation/integration effect of quality standards, implies statistically significant differences in demand elasticities with respect to the contract variety measure. Then, it is important to independently estimate the contract variety equation:

$$d_{i,t} = \lambda_1 s_{i,t} + \lambda_2 \text{HHI}_{i,t} + \lambda_3 \text{08-BL} + \lambda_4 \text{10-BL} + \rho_i + \rho_t + \mu_{i,t} \quad (4)$$

5 The contract varieties model

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Results

	Total Market (1)	<512Kbps (2)	≥512Kbps (3)	<1024Kbps (4)	≥1024Kbps (5)
s	0.0708*** (0.00514)	0.0202*** (0.00583)	0.0444* (0.0251)	0.0465*** (0.00467)	-0.259*** (0.0287)
hhi ₁	0.358*** (0.0312)	0.0858*** (0.0254)	0.525*** (0.0387)	0.276*** (0.0229)	0.420*** (0.0385)
hhi ₂	-0.771*** (0.0165)	-0.769*** (0.0154)	-0.846*** (0.0229)	-0.761*** (0.0146)	-0.684*** (0.0283)
hhi ₃	0.642*** (0.0356)	0.819*** (0.0295)	0.633*** (0.0489)	0.672*** (0.0270)	0.407*** (0.0535)
08-BL	0.242*** (0.0701)	0.212*** (0.0525)	0.611*** (0.0686)	0.364*** (0.0567)	0.698*** (0.0657)
10-BL	0.198*** (0.0159)	-0.152*** (0.0140)	0.695*** (0.0374)	-0.139*** (0.0146)	0.421*** (0.0357)
Constant	-0.189*** (0.0705)	0.00907 (0.0535)	-0.514*** (0.170)	-0.131** (0.0574)	1.706*** (0.202)
Observations	14,169	13,116	8,212	13,906	5,744
R-squared	0.652	0.705	0.699	0.682	0.713
Municipalities	1,048	1,030	747	1,046	518
Fixed Effects	✓	✓	✓	✓	✓

Notes: Robust standard errors in parentheses. The number of observations and municipalities refers to the total number of observations and municipalities in the unbalanced panel. Fixed Effects include time and municipality controls variables. Sample period: Quarterly 2005q4-2012q1. *** p<0.01, ** p<0.05, * p<0.1.

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- Quality standard regulation contributes to demand expansion of internet services.
- There is a positive relationship between contracts varieties and market penetration.
- The minimum quality standard reduces incentives to ISP to improve quality of services. Reaffirming statement of OECD 2014.