How Regulation and Enforcement of Competition Affects ICT Productivity

Evidence from Matched Regulatory-Production Surveys in Peru's ICT Sector

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Key results and hypothesis

- ICT adoption in LAC needs to catch up to peers
- ICT distortions in LAC are high, despite competitive regulatory environment
  - Hypotheses:
    - ★ Low skills to fully utilize ICT.
    - ★ Diffusion lags: Still in initial phase of regulatory change.
    - ★ **Weak enforcement** of competition policy.
- Results from our analysis show
  - Reducing ICT distortions lead to economy-wide productivity increases.
  - More and better competition policy is an important channel to reduce distortions - may not reduce markups.
  - Channel: Ability to innovate.

The importance of ICT for growth

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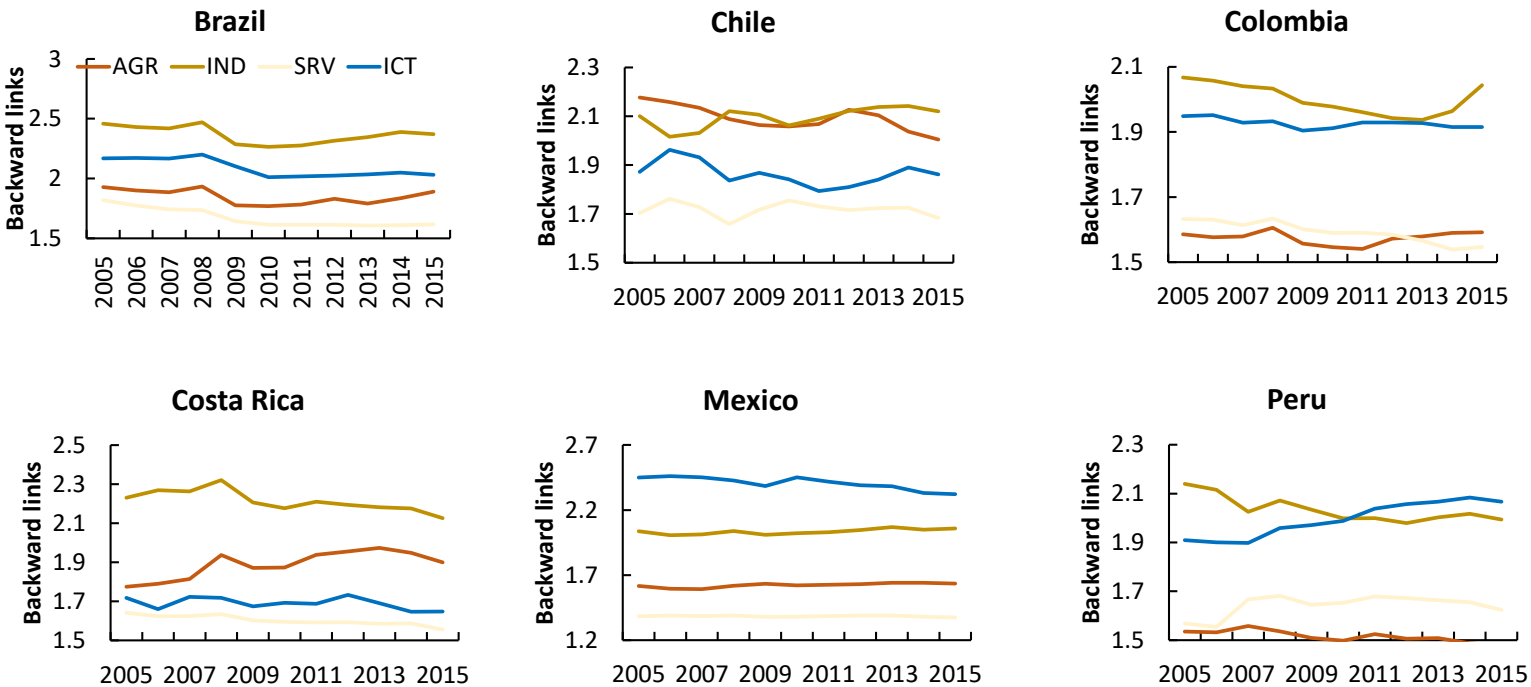
- ICT's contribution to productivity is directed through three channels.
  - Improves technological uptake (Alam 2008).
  - Improves utilization rates of production factors (Brynjolfsson and Hit 2010).
  - Improves the allocation of inputs (Biagi 2013).
- ICT's contribution to growth has historically been underestimated - hard to identify unobserved spillover channels (Van Reenen 2010).

ICT is important in the value-chain for LAC

Figure: Backward linkages of ICT



Source: Authors' using OECD Input Output data

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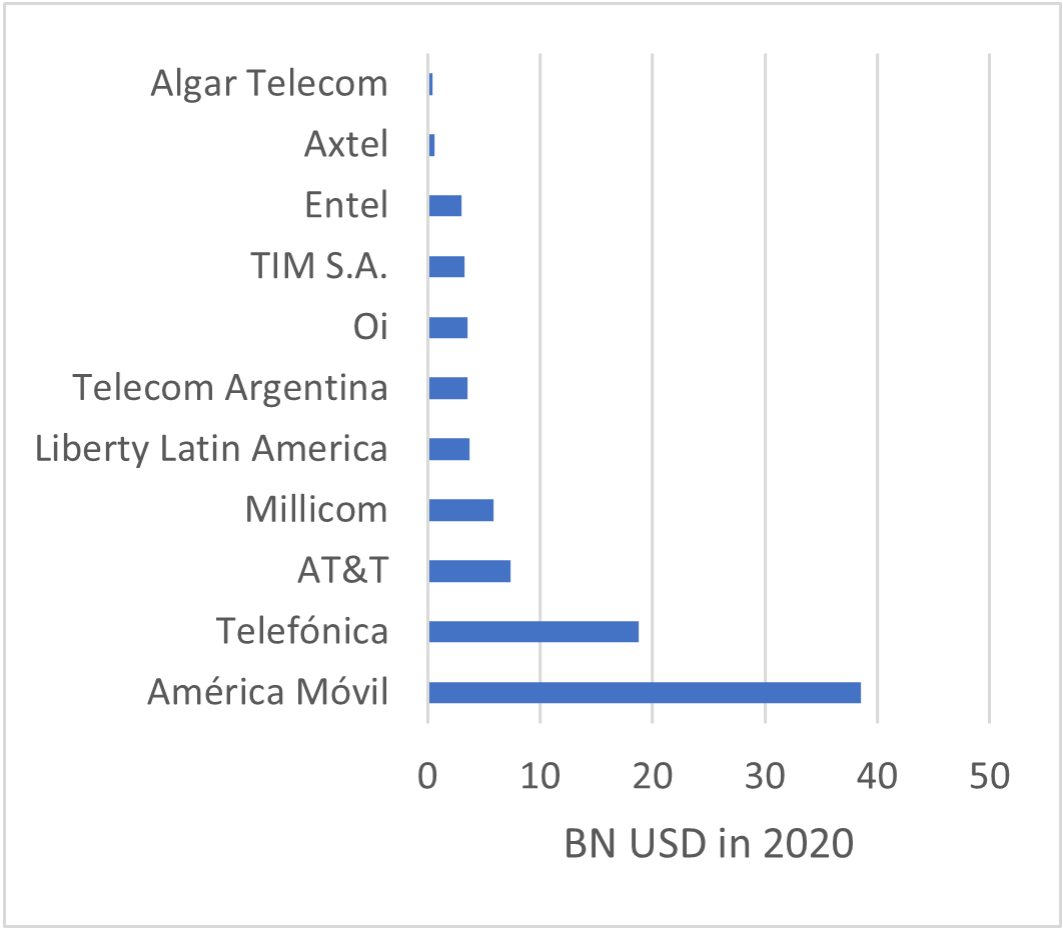
ICT markets in LAC can be uncompetitive

- Several countries have only access to a few network providers - monopoly may keep prices high.
- High spectrum prices, allocation delays and inappropriate award rules (such as short term license terms that discourage investments in network infrastructure) in LAC also constrain competition and investment, yielding high prices faced by consumers (GSMA 2018).
- The impact of ICT regulation becomes stronger as the value chain linkages between ICT and other sectors strengthen. If sectors invest less in ICT due to regulatory hurdles, it will hurt productivity (Van Reenen 2010).

Telecoms market is dominated by a few companies

Figure: Revenue generated by telecoms



Source: Statista

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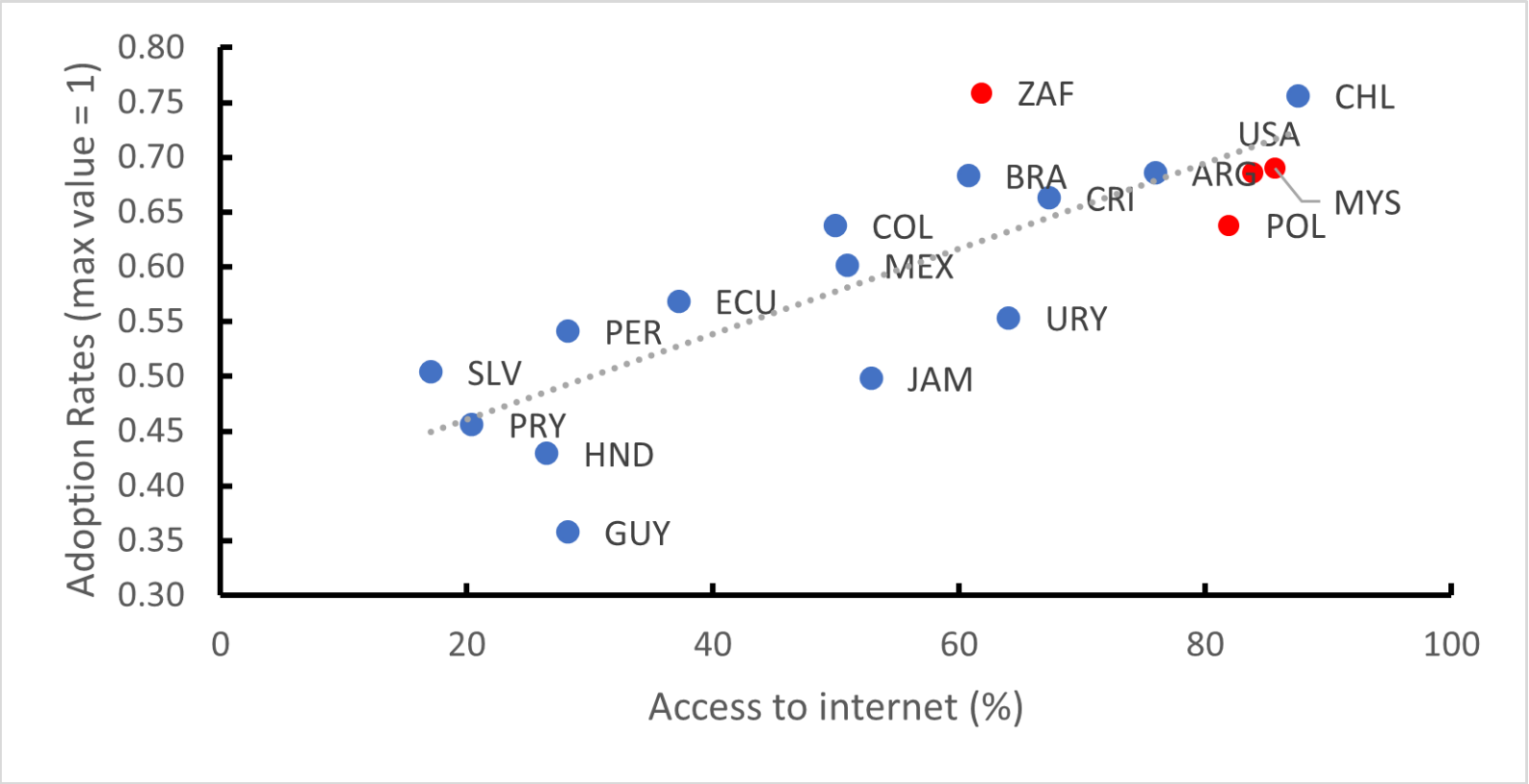
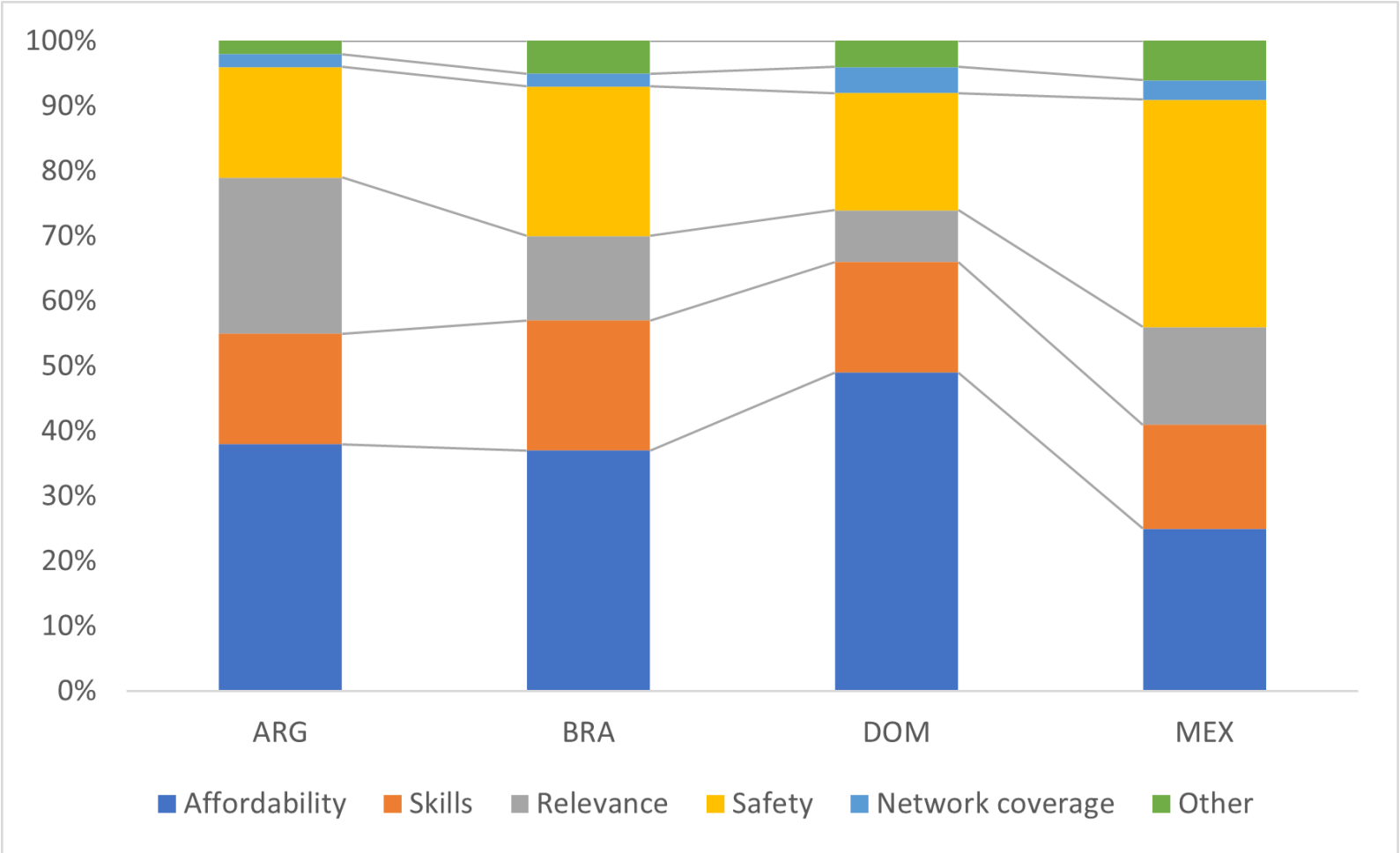
ICT adoption rates and access to the internet is unequal in LAC



Source: Authors' using ITU

Affordability is seen as a big constraint for adopting mobile internet



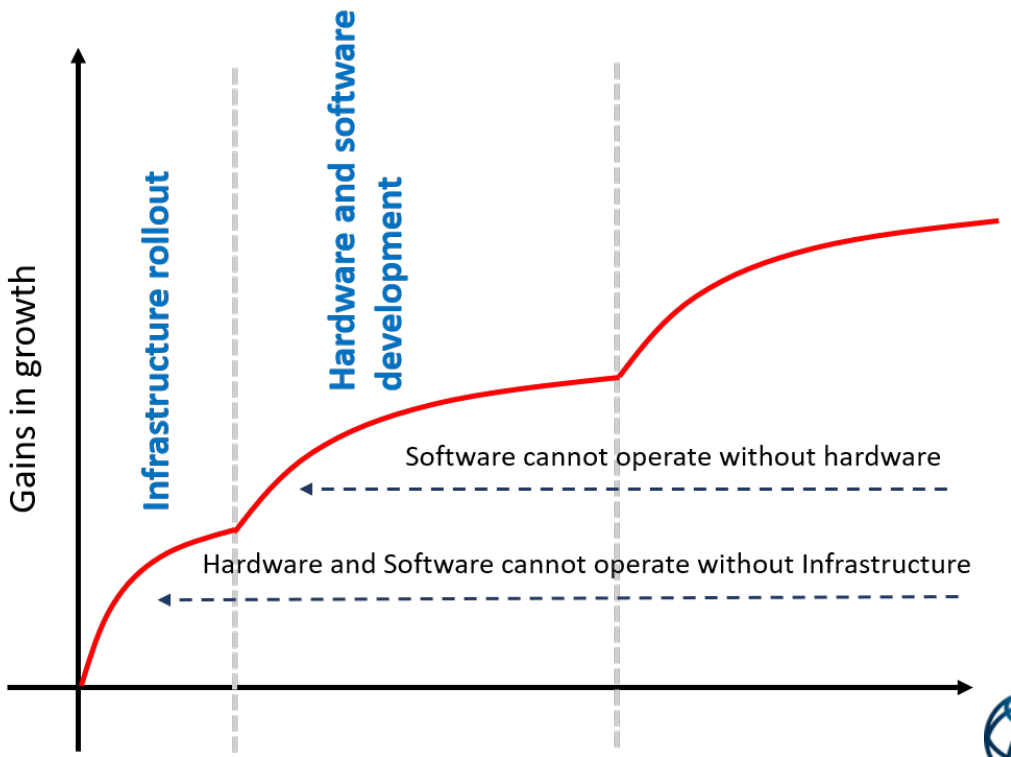
Source: GSMA

Inefficiencies imply slow growth

Inefficiencies at any stage may imply lagged and slow growth higher up the value chain

- Enforcement of competitive regulations can mean different things in various parts of the ICT value chain.

Figure: The ICT roll out phases and economic growth



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Regulations can foster competition

Competition in ICT sector and productivity are interlinked

- Important to distinguish natural monopolies from monopolies due to innovation or monopolies due to inefficiencies.
- Targeted regulation also needs to consider the importance of policy on network industries that have significant knock-on effects on downstream industries.
- Important to identify type of market:
  - Leveled markets (all firms in a market share the same technology) competitive pressure creates **escape competition** effects for firms that spend on innovation. These firms become leaders of the market and absorb a larger size of the market at the expense of laggards.
  - In unleveled markets, competitive pressure will also generate escape competition effects. However, laggards that are patient (i.e., value the future more than today), may imitate current leaders, thus catching up to them and become neck-and-neck firms. In this case productivity still increases, but the size of the market becomes more evenly distributed across firms.

Competition in ICT sector and productivity are interlinked

- The regulatory authority and a competition framework is important for generating higher ICT penetration rates and higher investments.
- The ITU shows that a 10% increase in their competition framework index generates a decrease of about 5% in prices faced by end-users, while a 5% reduction in bureaucratic barriers unlocks 17.05%. of additional capital investments.

Economic framework

- We calibrate a model to simulute productivity gains to understand the mechanism of regulation on productivity.
- Heterogenous firm model with endogenously variable markups (building on Edmond et al., 2015).
- The economy comprises
  - final good producer
  - non-ICT intermediate good producers
  - ICT intermediate good producers
- Fixed cost reduces a number of intermediate good producers, limiting competition, increasing the market share and markup of operating firms, as well as markup dispersion – the source of misallocation and productivity loss.

Final good producer

- Single consumption good produced using input $y(s)$ from sector s:

$$Y = \left(\int y(s)^{\frac{\theta-1}{\theta}} ds \right)^{\frac{\theta}{\theta-1}} \tag{1}$$

- Each input $y(s)$ is produced from both traditional and ICT intermediate inputs, x_i and z_i:

$$y(s) = \left(\sum_{i=1}^{n^x(s)} x_i(s)^{\frac{\gamma-1}{\gamma}} + \sum_{i=1}^{n^z(s)} z_i(s)^{\frac{\gamma-1}{\gamma}} \right)^{\frac{\gamma}{\gamma-1}} \tag{2}$$

where $\gamma > \theta$ is the elasticity of substitution across inputs within a particular sector s

Intermediate good producer

- Two intermediate firms - traditional (x) and ICT (z) for firm i:

$$x_i(s) = a_i^x(s) l_i^x(s) \tag{3}$$

$$z_i(s) = a_i^z(s) l_i^z(s) \tag{4}$$

- Intermediate good firms engage in Cournot competition within a sector. Firms choose a quantity to maximize its profit:

$$\max_{x_i(s)} \left[\left(p_i^x(s) - \frac{w}{a_i^x(s)} \right) x_i(s) \right], \tag{5}$$

- Same with the ICT sector:

$$\max_{z_i(s)} \left[\left(p_i^z(s) - \frac{w}{a_i^z(s)} \right) z_i(s) \right] \tag{6}$$

Intermediate good producer

- The maximization problems imply that intermediate good firms charge a markup over marginal cost

$$p_i^x(s) = \frac{\varepsilon_i^x(s)}{\varepsilon_i^x(s) - 1} \frac{w}{a_i^x(s)}, \tag{7}$$

$$p_i^z(s) = \frac{\varepsilon_i^z(s)}{\varepsilon_i^z(s) - 1} \frac{w}{a_i^z(s)}, \tag{8}$$

- where the demand elasticities can be written as:

$$\varepsilon_i^x(s) = \left[\left(\frac{p_i^x(s)}{p(s)} \right)^{1-\gamma} \frac{1}{\theta} + \left(1 - \frac{p_i^x(s)}{p(s)}^{1-\gamma} \right) \frac{1}{\gamma} \right]^{-1}, \tag{9}$$

$$\varepsilon_i^z(s) = \left[\left(\frac{p_i^z(s)}{p(s)} \right)^{1-\gamma} \frac{1}{\theta} + \left(1 - \frac{p_i^z(s)}{p(s)}^{1-\gamma} \right) \frac{1}{\gamma} \right]^{-1}. \tag{10}$$

Intermediate good producer

- $\left(\frac{p_i^x(s)}{p(s)}\right)^{1-\gamma}$ and $\left(\frac{p_i^z(s)}{p(s)}\right)^{1-\gamma}$ are the firms' share of sectoral revenue, and $\varepsilon_i^x(s)$ and $\varepsilon_i^z(s)$ are the demand elasticity faced by firms. As $\gamma > \theta$, firms with larger shares of sectoral revenue face lower demand elasticity and can charge higher markup. The markup a firm charges is an increasing convex function of its market share. The more firms enter the market, the lower the markup is.

Aggregate productivity

- Aggregate productivity can be expressed as a function of markup:

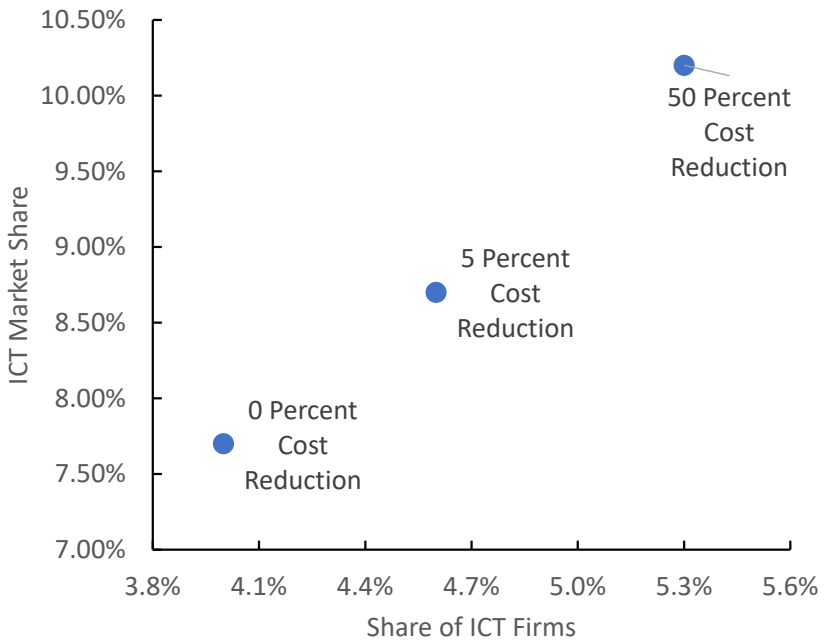
$$A = \left(\int \left(\frac{\mu(s)}{\mu} \right)^{-\theta} a(s)^{\theta-1} ds \right)^{\frac{1}{\theta-1}} \tag{11}$$

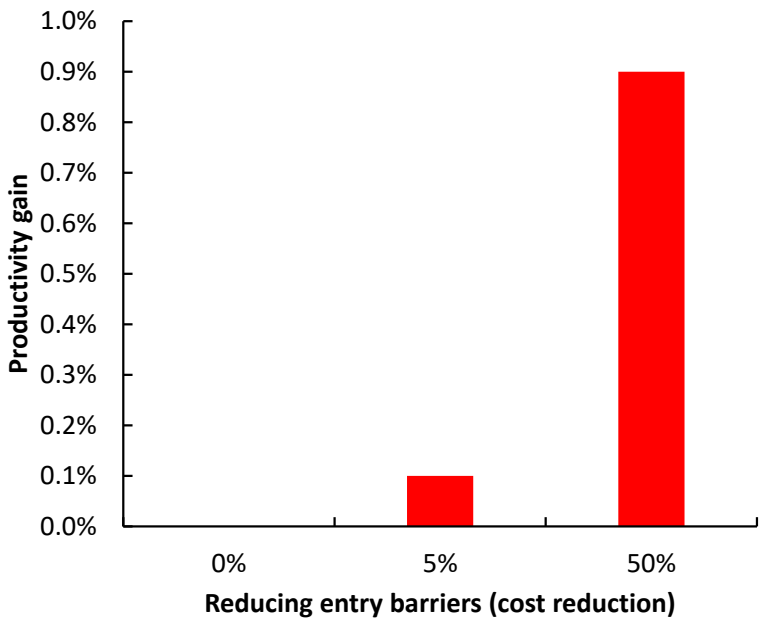
- and the sector-level productivity is

$$a(s) = \left(\sum_{i \in l,h} n_i^x(s) a_i^x(s)^{\gamma-1} \left(\frac{\mu_i^x(s)}{\mu(s)} \right)^{-\gamma} + \sum_{i \in l,h} n_i^z(s) a_i^z(s)^{\gamma-1} \left(\frac{\mu_i^z(s)}{\mu(s)} \right)^{-\gamma} \right)^{\frac{1}{\gamma-1}}$$

- The higher the dispersion in markups, the lower overall productivity
- Task is to identify how regulation affects productivity, through dispersion in markup channel

Simulation results - a Peruvian calibration





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Empirical evidence from Peru

Firm-level data

- Firm-level data from the Annual Economic Survey (EEA) is collected by the National Institute of Statistics (INE) for 2007-17
- Nationally representative of Peruvian firms at the four-digit ISIC code level
- ICT sector, which we separate into hardware, software, telecommunications, and infrastructure subsectors

Regulation data

- Data are drawn from the Peruvian regulatory authorities: the Ministry of Transport and Communications (MTC), Osiptel for telecommunications and infrastructure, and Indecopi for other regulations pertaining to software and hardware.
- The applicable regulations are laws and decrees issued between 2007 and 2017 that specifically target the ICT sector and either facilitate or complicate competition.
- Facilitating regulations improve the administrative efficiency of entering or operating in an ICT market, improving competition by facilitating both market entrance and resource allocation, and potentially contributing to productivity growth.
- Regulations that impose additional administrative requirements or make current ones more complex are likely to generate the opposite effect, hindering market entrance, limiting resource movement, and thus deterring productivity growth.

Enforcement data

- Osiptel and Indecopi enforcement data capture the number of investigations of anti-competitive behavior that resulted in a fine or a corrective measure in each year and sector.
- Additionally, for telecommunications, the data set contains the fines by company name, which are then mapped to a corresponding ISIC code
- Each resolution that found infringements to competition law defines the market affected at the 4-digit ISIC level and the year for which the correction of competition was enforced.
- Competition enforcement is exogenous to firm performance:
  - Enforcement is applied nationwide regardless of firm or regional idiosyncrasies.

Matching data

- We match changes in regulations and their enforcement over time to the firm-level panel.
- Regulatory cases are matched to firm data by looking at the market affected, defined by the 2-digit ISIC sector and by the year of implementation
- We compare the behavior of these firms to that of firms in the same ICT branch that were not subjected to any new regulation.
- The regulatory variables are coded as dummies where 1s imply a change in regulation.

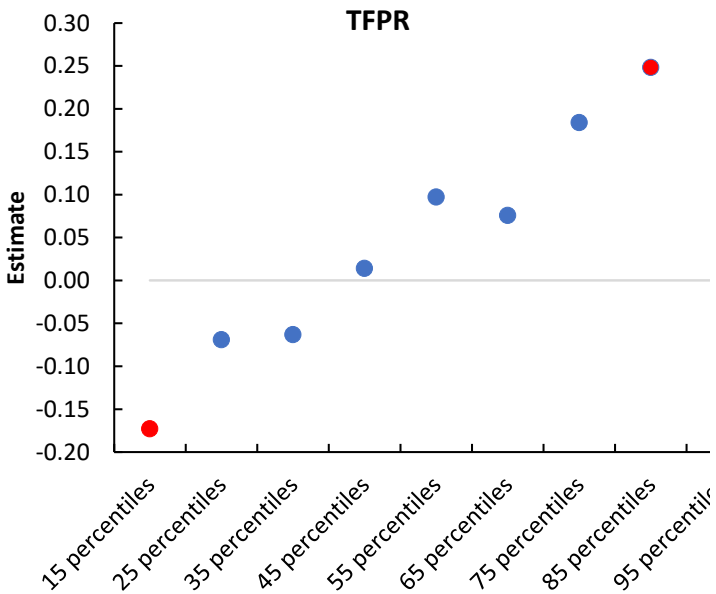
Methodology

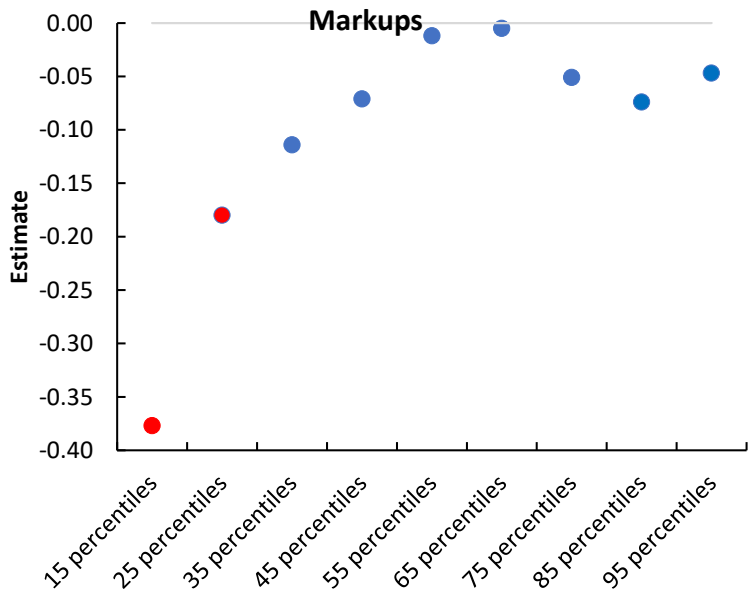
- The methodology relies on Jooste, Sampi and Vostroknutova (2021), contolling for possible demand shifters and a lack of product price data (see Bond et al. 2020). The joint-system of equations are:

$$
\begin{aligned}
-\log S_{Xjt} &= \tau_t + \tau_1^{\mu} z_{1jt} + \tau_2^{\mu} z_{2jt} - \log(\gamma_0(\log K_{jt} - \log N_{jt}))^{\gamma} + \epsilon_{jt}^{\mu} \\
\log Q_{jt} &= \log F_{jt} + \phi_t + \omega(\log Q_{jt-1} - \log F_{jt-1} - \epsilon_{jt-1}) + \phi_1^{\omega} z_{1jt} + \phi_2^{\omega} z_{2jt} +
\end{aligned}
\tag{13}
$$

The impact of enforcement on market leaders

- Competitive forces lead to escape competition effects for market leaders, but lower productivity for laggards - the overall dispersion in markups fall.





Red dots imply statistical significance at 5% level

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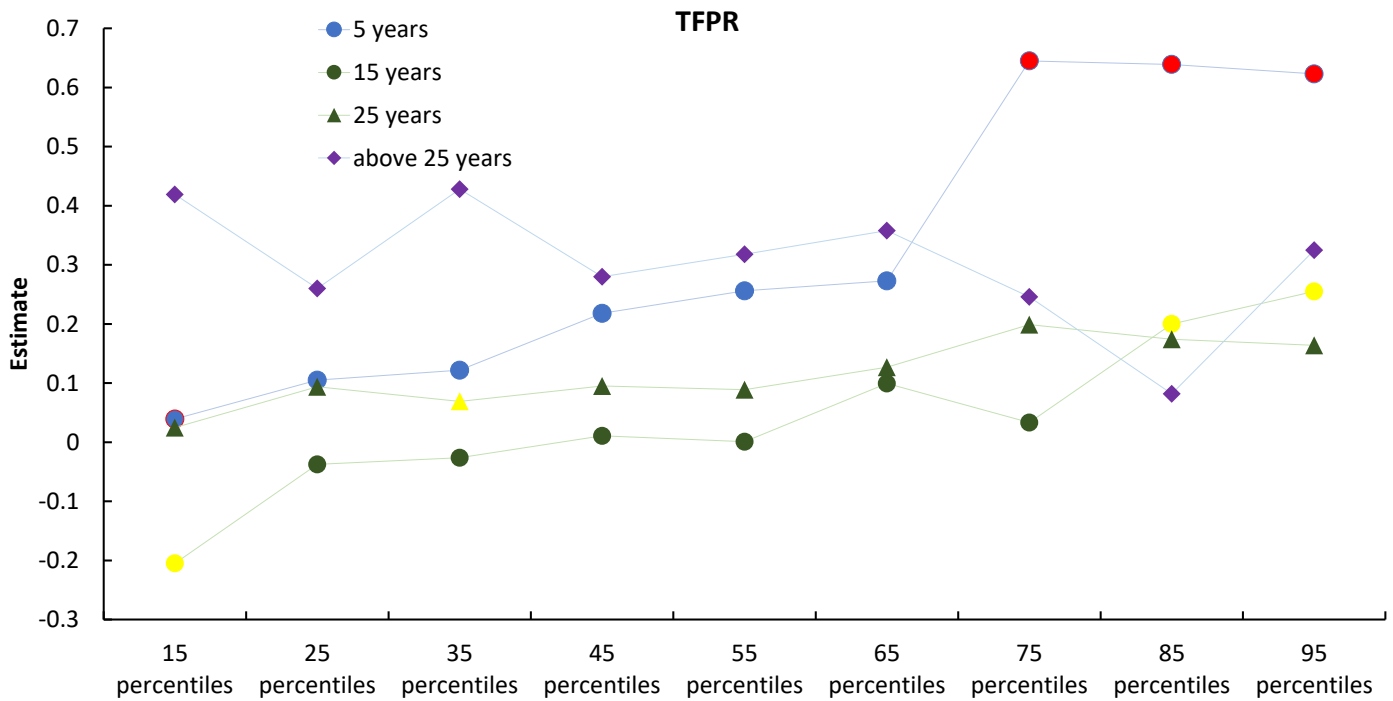
Younger and middle-aged firms are able to adapt more to regulation

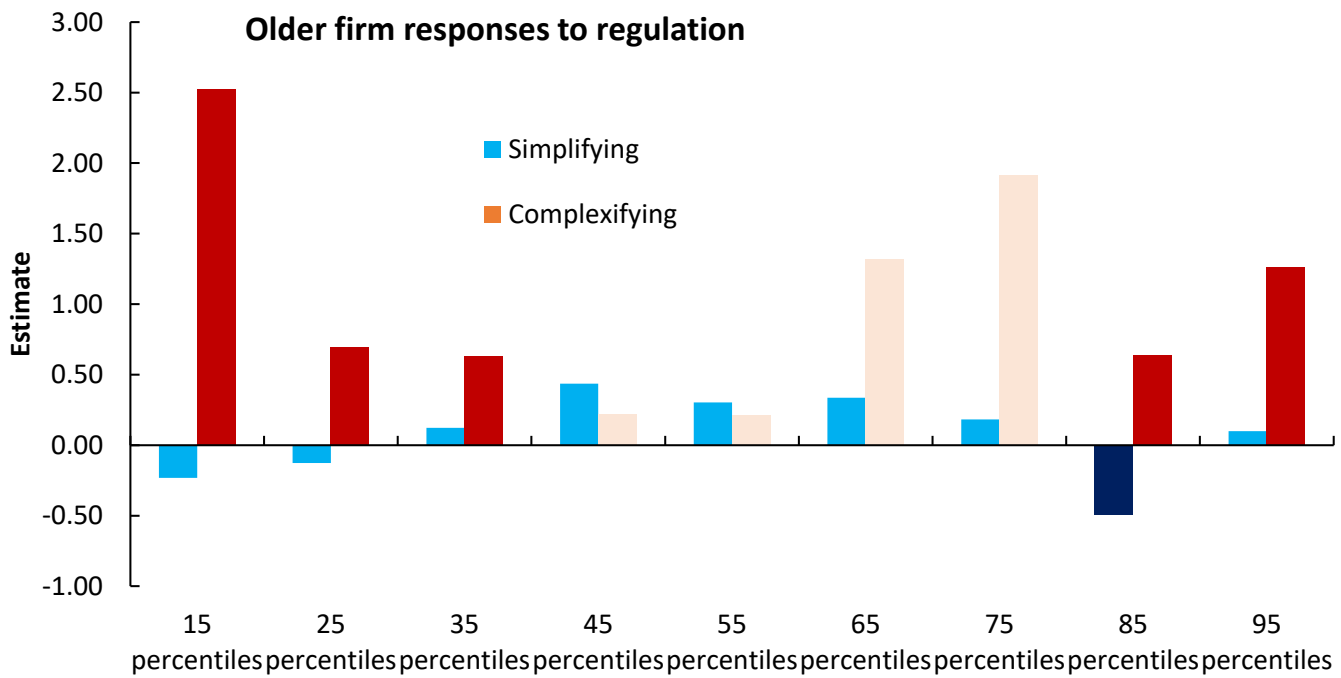
- Any regulation benefits productivity middle-aged firms more than older and unproductive firms



Red and yellow dots imply statistical significance at 5% level

While older firms respond more to regulations that talk to experience

- Younger firms do worse with complexifying regulations, while older firms use experience to benefit from these regulations



Dark red and blue bars imply statistical significance at 5% level

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Conclusion

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- Enforcement and regulation lead to productivity improvements.
- Middle-aged and older firms (more experienced firms) adjust more readily to competitive forces
  - The exception is for regulations that simplify processes - young productive firms respond relatively better to these type of regulations.
- The dispersion in markups fall, but results are not signficant