

# Effects of Regulation on Innovation in the Information and Communications Sector

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# Background and goals

- Regulatory economics and practice, until recently paid much more attention to static efficiency than to issues of innovation
  - Regulatory process and innovation (Bailey, 1974; Prieger, 2002, 2007, 2008)
  - Price cap regulation and investment (Greenstein et al., 1995; Ai & Sappington, 2002)
  - Unbundling, net neutrality and innovation (Bourreau and Doğan; 2001; van Schewick, 2010; Reggiano & Valletti, 2011)
- Paper aims at examining whether regulation has detectable effect on sector innovation activity

# Overview

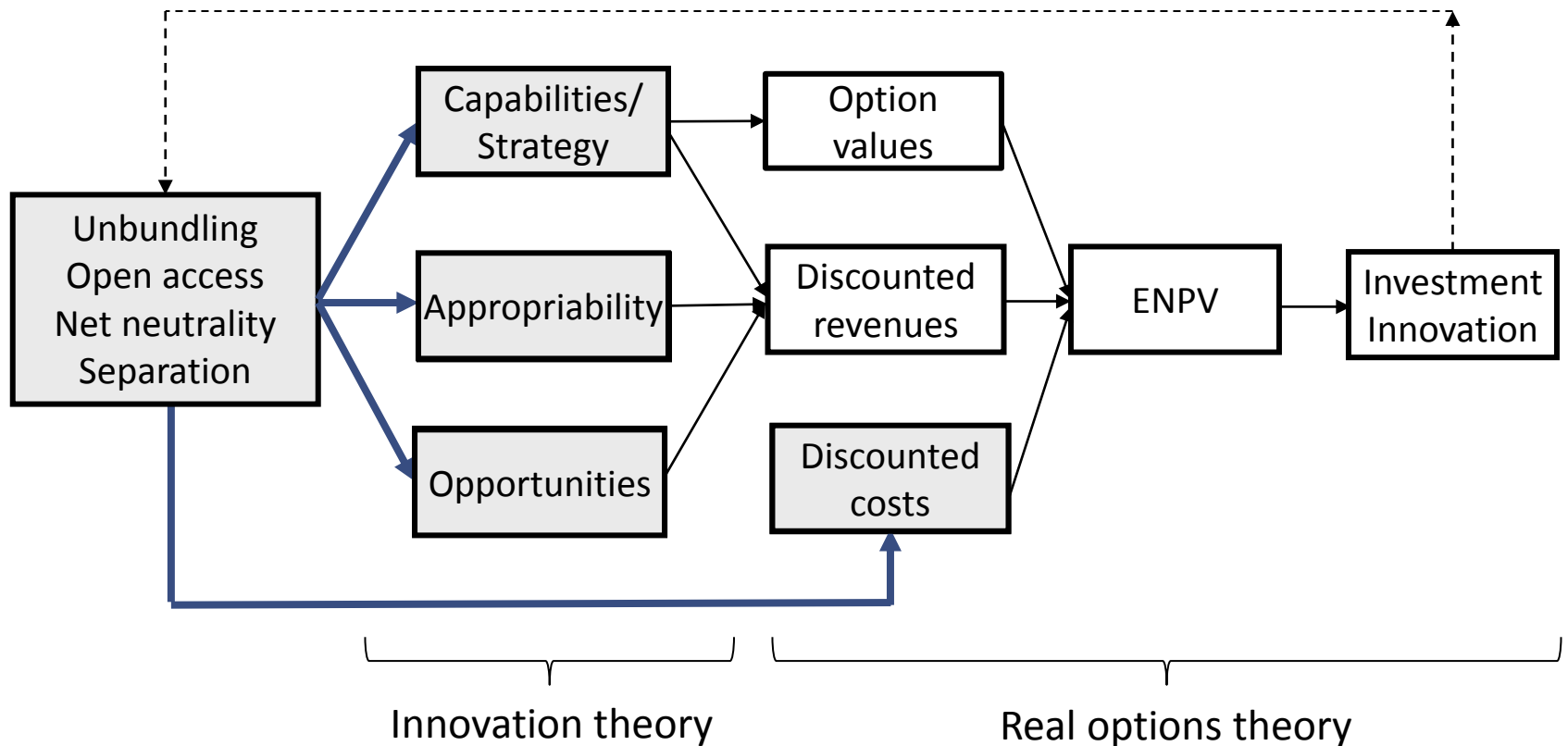
- Conceptual framework
- Empirical approach and findings
- Policy implications

# Conceptual framework

# Re-conceptualizing innovation

- Traditional view (OECD Oslo Manual, 2005)
  - production process, product, good, or service
  - marketing method, organizational method
- Innovation as an evolutionary process
  - Innovation as re-combination of known elements (Nelson & Winter, 1982, Arthur, 2009, Antonelli 2010)
  - Digital economy: continuous experimentation—real-time feedback—rapid sharing—replication of successful models (Brynjolfsson, 2012)
- How does regulation influence this process?

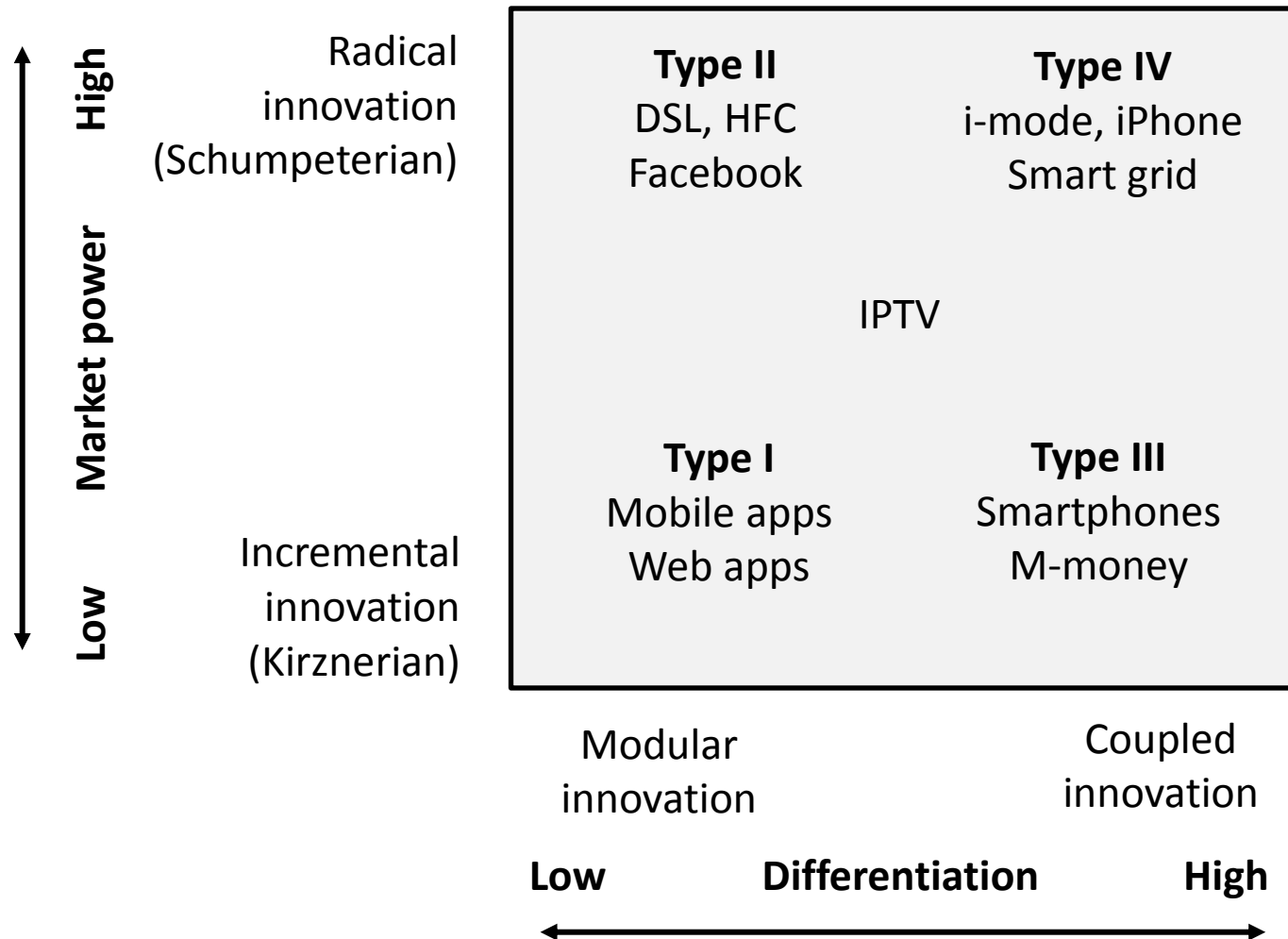
# Regulation and innovation decisions: a microfoundation



# Heterogeneity of incentives

- Asymmetric regulation influences innovation incentives of different players in positive and negative ways
  - Affects timing and direction of innovation (e.g., both incumbents and new entrants have an option to wait)
  - Creates trade-offs between innovation incentives of players (e.g., content providers, network operators)
- Innovation occurs in many forms and the design of regulation influences them differently
  - Open access to platforms supports modular types of innovation but may complicate coupled innovations
- Feedbacks in ICT system render overall effects difficult to gauge analytically

# Innovation types, enabling conditions



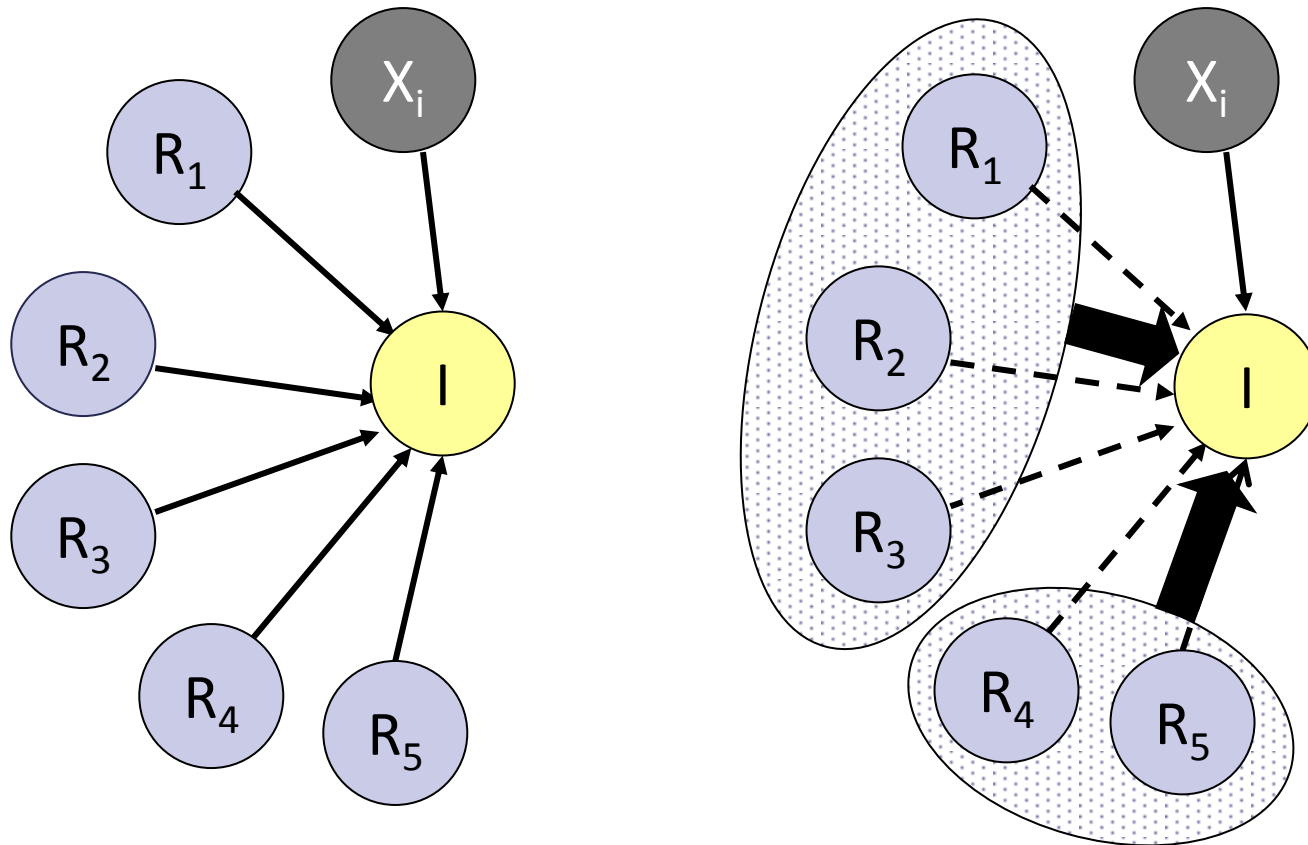


# Selected conjectures

- Type I modular innovation processes are enhanced by a regulatory framework that reduces transaction and adaptation costs
- Type II radical innovation processes are facilitated by a regulatory framework that allows temporary higher innovation premiums
- Type III incremental but coupled innovations are facilitated by a framework that permits differentiation of network access and services
- Type IV incremental but coupled innovations are facilitated by a framework that allows differentiation and temporary exclusive agreements
- Overall regulatory density reduces experimentation opportunities and dampens innovation (system effect)

# Empirical approach and findings

# Modeling governance arrangements



R ... regulatory instruments, X ... external, control factors, I ... innovation

# Modeling approach

- General estimation model

$$I_{it} = \alpha_{it} I_{it-1} + \beta_1 R_{it} + \delta X_{it} + e_{it}$$

$I_{it}, I_{it-1}$  Innovation activity in country  $i$  at time  $t, t-1$

$\alpha, \beta_1, \beta_2, \delta$  Parameters

$R_{it}$  Regulatory density in country  $i$  at time  $t$

$X_{it}$  Independent and control variables

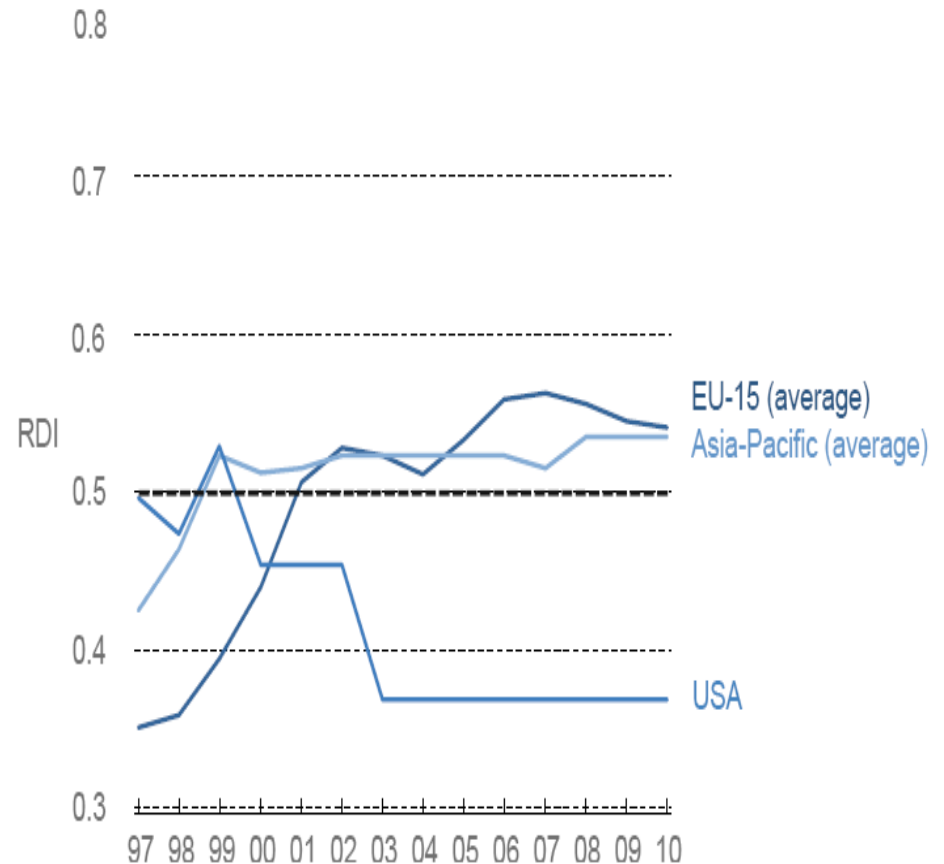
- Dynamic panel estimation, instruments to overcome problems of endogeneity
- Examination of data for non-linear effects of regulatory density

# Data

- Data for 32 countries (EU-27, AU, CH, JP, SG, US), 1997-2010 (up to 448 observations)
- Dependent variables: innovation proxies
  - Network process innovation (adoption of first-generation broadband)
  - Service and application innovation (secure servers)
- Independent variables
  - Components of Regulatory Density Index 2012
  - Economic and socio-demographic variables

# Regulatory Density Index

- 41 components (fixed, mobile, NGN, market entry, general regulation)
- Scores each component on a 0-1 interval, based on stringency of regulatory constraint
- Annual data, 1997-2010 (NGN only 2007-2010)



Source: Polynomics, 2012

# Selected findings

Variable	Fixed BB/100	Fixed BB/100	Fixed BB/100	Servers/100	Servers/100	Servers/100
$(\text{Servers}/100)_{t-1}$	0.8267*** (0.0359)	0.8332*** (0.0463)	0.8374*** (0.0318)	1.1038*** (0.0361)	1.1014*** (0.0392)	1.0793*** (0.0416)
Total regulation	-3.5179* (2.0549)			-0.0019* (0.001)		
$(\text{Total regulation})^2$	0.1972* (0.1121)			0.0001* (0.0001)		
Price regulation		-16.5032** (7.5028)			-0.0082*** (0.0031)	
$(\text{Price regulation})^2$		3.1228** (1.3938)			0.0017*** (0.0006)	
Entry regulation			-3.322* (1.7612)			-0.0079*** (0.003)
$(\text{Entry regulation})^2$			0.3243* (0.1704)			0.0007*** (0.0003)
log(GDP)	17.5306*** (2.9368)	19.1458*** (4.5989)	18.1091*** (2.6422)	0.0161*** (0.0036)	0.0117*** (0.0038)	0.0202*** (0.0047)
Urban population rate	0.8728*** (0.3090)	0.4195 (0.4513)	0.8387*** (0.2287)	0.0007 (0.0008)	0.0006 (0.0008)	0.0009 (0.0008)
$\chi^2$	3863.90 p>0.001	1995.92 p>0.001	4355.98 p>0.001	2269.56 p>0.001	2201.35 p>0.001	1742.97 p>0.001
N	232	232	232	300	300	300

Note: Standard errors in parentheses. \*, \*\* and \*\*\* denote significance at 10%, 5% and 1%, respectively.

# Regulation “elasticities”

(at sample means)

Dependent variable: fixed broadband connections (Type II)			
	Fixed/100	Fixed/100	Fixed/100
Total Regulation	-0.0503*		
Price Regulation		-0.3030**	
Entry Regulation			-0.0132*
Dependent variable: secure servers (Type III)			
	Servers/100	Servers/100	Servers/100
Total Regulation	-0.0517*		
Price Regulation		-0.0090***	
Entry Regulation			-0.1315***

Note: \*, \*\* and \*\*\* refer to significance level of 10%, 5% and 1% of the respective parameter estimates.



# Discussion and caveats

- Innovation theory and empirical evidence suggests that more ubiquitous and intrusive regulation (higher “regulatory density”) slows innovation experiments
- Evidence that this relation is non-linear and asymmetric: less and more regulation can increase innovation performance compared to the sample mean but less regulation has a stronger effect
- Preliminary tests using other innovation metrics (IPTV, FTTH, 3G/LTE) were constrained by limited numbers of observations (and did not show strong results)
- Analysis focuses on aggregated measures of regulatory intervention. Effects at the level of single components are difficult to establish and may be unstable.

# Policy implications

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1. Where choices between more intrusive and less intrusive instruments exist, the latter seem to have advantages from an innovation perspective
2. Regulatory design needs to take the multiplicity of innovation types into account and realize that they are facilitated by different conditions
3. Because no single framework can support all types of innovation equally, trade offs should be evaluated explicitly
4. Institutional diversity therefore may be a good meta-strategy to enable diverse innovation