Telecommunications industry and economic growth: How its market structure matters

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Empirical studies suggest that the telecommunication industry (telecom) has a significant contribution to economic growth:

- Emphasized channels: infrastructure investments; network externalities
  - e.g., Roller & Waverman (2001); Czernich, Falck, Kretschmer, & Woessmann (2011)

The literature suggests that the market structure of an industry can matter for its contribution to economic growth:

- Emphasized channels: innovative activities; inefficiencies stemming from imperfect competition
  - e.g., Nickell (1996); van de Klundert & Smulders (1997); Aghion, Bloom, Blundell, Griffith, & Howitt (2005)
Many recent policies propose changes in the market structure of telecom and have initiated such changes already.

- e.g., the Telecommunications Act of 1996, in the US; the directives 90/388/EEC, 96/19/EEC, 2002/22/EC, and 2002/58/EC in the EU.
This paper analyses how the market structure of telecom matters for its contribution to long run growth in terms of innovation by incumbents and entrants; and

- shows how the competition type in telecom market can matter for that contribution;
- suggests the direction of policies that can deliver higher welfare in the decentralized equilibrium;
- evaluates several implications of the recently implemented policies;
- focuses on the productivity improvement in telecom.
Telecom features - Products, market, and firms

Telecom firms

- produce imperfectly substitutable products (e.g., wireless and land-line services)
- operate in monopolistic environment
- are known to be relatively large and long lasting firms
  - e.g., Vodafone was created in 1983 and in 2011 its market value is $148bln
Telecom features - Investments and innovation

Telecom firms

- carry substantial investments before the entry to the markets
  - e.g., they build infrastructure in order to provide their services

- enhance their productivity through continual investments, after the entry
  - e.g., digitalization of networks

- engage in R&D partnerships and cross-licensing activities (Hagedoorn 1993; 2002)
Telecom features - Network externalities

The products of telecom firms create two types of positive network externalities amongst their users (Gandal, 1995)

- **Direct Network Externalities** increase the value of using a telecom good with the number of users
  - In the light of productivity improvement in telecom, the "number of users" is replaced by "effective number of users"

- **Indirect Network Externalities** stem from existence of different types of telecom goods, given that a user of a telecom good can access other telecom goods also
In decentralized equilibrium

- the market structure of telecom matters for social welfare due to imperfect competition in telecom market
  - the demand for telecom goods is lower (compared with the socially optimal one), while the productivity improvement in telecom goods is one of the drivers of economic growth
In decentralized equilibrium, when there is finite number of telecom firms,

- changing the market structure or the toughness of the competition (Cournot vs. Bertrand; Sutton, 1991) affects the productivity improvement in telecom and the demand for telecom goods

- increasing the number of firms or toughening the competition increases the social welfare
Depending on economy, there are two cases in decentralized equilibrium:

- the entry to telecom either stops after some number of firms have entered
  - endogenous barriers to entry
- the entry continues forever
  - monopolistic competition, in long run

In social optimum:

- there is permanent entry
The results suggest that the policies which can improve the welfare in decentralized equilibrium

- subsidize the production of telecom goods (or the demand)
- allow free entry and subsidize it, if needed, in order to guarantee permanent entry
- subsidize the investments for productivity improvement
  - the last two points tend to be overlooked in the recently implemented policies (e.g., the Telecommunications Act of 1996)
Recently implemented policies may have increased the substitutability between telecom goods

- e.g., the Telecommunications Act of 1996 mandates number portability and motivates interconnectedness

(ii) this type of policy is not in-line with social optimum, where lower substitutability implies higher welfare

(iii) in competitive equilibrium its effect is ambiguous, when there are no exogenous barriers to entry

(iii) in case of exogenous barrier to entry (and exit) increasing the substitutability can deliver higher GDP growth rate

- thus it may deliver higher welfare
This paper uses a general equilibrium framework

- it can explicitly suggest how the telecom can affect the growth
- it can suggest the general equilibrium effects of policies
Most notably, the framework developed in this paper incorporates

- firm entry to telecom market
  - in order to endogenize the market structure of telecom
- innovation in telecom by incumbents
- trade of patents (production instructions; knowledge for production) in telecom
  - stands for R&D partnerships and cross-licensing
- direct network externalities
  - not endogenous; do not drive the main results of the paper
Multi-sector endogenous growth model for telecom

Two sectors

- Final good sector
  - Final good producers produce a homogenous good $Y$, which is the numeraire good

- Telecom
  - Each telecom firm produces a distinct type of telecom good $x$
The representative producer’s problem:

\[
\max Y = \tilde{X}^\mu X^\sigma L_Y^{1-\sigma} \\
s.t. \\
X = \left( \sum_{j=1}^{N} \frac{x_j^{\varepsilon-1}}{\varepsilon} \right)^{\frac{\varepsilon}{\varepsilon-1}} \\
\mu > 0, \varepsilon > 1, \sigma \in (0, 1) \\
in equilibrium \tilde{X} = X
\]
Given the (inverse) demand of telecom good the $j$th ($\forall j = 1, \ldots, N$) producer’s problem is

$$\max \quad V_j(t) = \int_{t}^{\infty} \pi_j(\tau) \exp \left[ -\int_{t}^{\tau} r(s) \, ds \right] \, d\tau$$

Cournot: $L_{x_j}, L_{r_j}, \{u_{j,i}, u_{i,j}\}_{i=1; (i\neq j)}^{N}$

Bertrand: $p_{x_j}, L_{r_j}, \{u_{j,i}, u_{i,j}\}_{i=1; (i\neq j)}^{N}$

s.t.

$$\pi_j = p_{x_j} x_j + \sum_{i=1; i\neq j}^{N} p_{u_{j,i}\lambda_j} (u_{j,i}\lambda_j) - (L_{x_j} + L_{r_j}) w - \sum_{i=1; i\neq j}^{N} p_{u_{i,j}\lambda_i} (u_{i,j}\lambda_i),$$

$$x_j = \lambda_j L_{x_j},$$

$$\dot{\lambda}_j = \zeta \left[ \sum_{i=1}^{N} (u_{i,j}\lambda_i)^{\alpha} \right] \lambda_j^{1-\alpha} L_{r_j}; u_{j,j} \equiv 1, \zeta > 0, 0 < \alpha < 1.$$
The entrant borrows the resources for entry investment $S$ from household with the interest rate $r$. The investment is in terms of final good and has its productivity $\eta$. The creation of the distinct type of telecom good is given by

$$\dot{N} = \eta S$$

$$\eta > 0$$
Household side

A continuum of identical and infinitely lived households of mass one

- Each household is endowed with constant amount of labor, $L$

Household’s optimality problem:

$$\max U = \int_0^\infty \frac{C_t^{1-\theta}}{1-\theta} e^{-\rho t} dt$$

s.t.

$$\dot{A} = rA + wL - C$$

$\theta > 0, \rho \in (0,1)$
Economic growth is higher if the number of telecom firms is higher and/or the competition is tougher in any of telecom markets (Cournot vs. Bertrand; Sutton, 1991)

\[ g - GDP \text{ growth rate; } L - Lerner \text{ index} \]

(1) - Bertrand competition; (2) - Cournot competition
Depending on household’s preferences and production technologies there are two cases in the economy

- **Case 1** – endogenous barriers to entry
- **Case 2** – permanent entry
The number of telecom firms is finite and constant; it can be derived from a zero profit condition.

- Under Bertrand competition

\[ N^B = (\varepsilon - 1) \frac{\bar{\xi}L - \frac{\rho}{\sigma}}{\varepsilon (\bar{\xi}L - \frac{\rho}{\sigma}) - \bar{\xi}L [(\theta - 1) (\sigma + \mu) + 1]} \]

- Under Cournot competition

\[ N^C = (\varepsilon - 1) \frac{\bar{\xi}L [(\theta - 1) (\sigma + \mu) + 1]}{\varepsilon (\bar{\xi}L - \frac{\rho}{\sigma}) - \bar{\xi}L [(\theta - 1) (\sigma + \mu) + 1]} \]
Telecom contributes to economic growth through productivity improvements in telecom good production

Economic growth increases with the scales of direct network externalities
On balanced growth path

- there are infinitely many telecom firms

- telecom contributes to economic growth through the productivity improvements in telecom good production and through growth in the number of telecom firms

- toughening the competition and increasing the number of telecom firms does not affect economic growth

- economic growth increases with the scales of direct network externalities
Motivation and research
Outline of results/contributions
Methodology/The model
Results/conclusions - 1
Results/Conclusions - 2

Results - Competitive equilibrium vs. social optimum

- Due to price setting behavior of telecom firms and the direct network externalities the market price of telecom good is not equal to its marginal value (and cost)
- In competitive equilibrium there is under-investment in productivity improvement
  - In addition, the returns on investments decline with entry of firms in competitive equilibrium, in contrast to social optimum
- In social optimum there is permanent entry, in contrast to the competitive equilibrium where there can be endogenous barriers to entry
The policies that deliver socially optimal allocations as a competitive equilibrium outcome

- subsidize the production of telecom goods (or tax the demand)
- subsidize the investments for productivity improvement
- allow free entry and subsidize it, if needed, in order to guarantee permanent entry

Policies which increase the substitutability between telecom goods are not in-line with social optimum