Estimating the effect of competition on productivity growth

Alejandro Parraguez

March 7, 2017

Research Question and Approach

- What is the effect of market competition and economic growth?
- **Empirical evidence** establishes that innovation increases with PMC while **theory** predicts it declines with PMC
- Aghion et al. 2005 finds the existence of an inverted-U pattern and develops a general model that explains it
- The paper will use GMM to estimate the parameters of the model they develop using firm level data from Chile

Data description

- **Firm productivity**: 2007 and 2009 Longitudinal Survey of Firms (LSF) from the Ministry of Economy. Cross-sectional dataset including formal private firms. Sample size of 10,213 firms represents 744,000 firms (93% of all firms in the country) and provides firm level accounting information.
- **Firm R&D expenditure:** 6th Survey of Firm Innovation (2007-2008). Includes private firms with sales over 94,200 USD, and provides information on innovation activities.

Preferences and Intermediate good production

- $u(y_t) = \ln y_t$ and and intertemporal utility function

$$u = \int_t^{\infty} e^{-rt} (\ln y_t - l_t) \, dt$$

- For $\ln y_t = \int_0^1 \ln x_{jt} dt$ and x_{jt} is produced by two duopolists: $x_{jt} = x_{Ajt} + x_{Bjt}$ and expenditure $E = p_{Aj} x_{Aj} + p_{Bj} x_{Bj}$ is the same across intermediate goods.
- Production of x_{it} is:

$$x_{it} = \gamma^{k_i} l_{it} \; i = A, B$$

where k_i is the technological level of firm i

- Cost function $C(x) = x \cdot \gamma^{-k_i}$

Industry Competition

- State of industry is given (l, m) where l is the leader technology and m is the gap between the leader and follower
- Two types of intermediate industries: leveled with $m = 0$ and unleveled with $m = 1$
- **Unleveled profits**: from Bertrand competition and limit pricing $\pi_1 = \left(1 - \frac{1}{\gamma}\right)$ and $\pi_0 = 0$
- **Leveled profits**: possibility of collusion $\pi_0 = \varepsilon\pi_1$ where $\varepsilon \in \left[0, \frac{1}{2}\right]$. Measure of competition $\Delta = 1 - \varepsilon$

Optimal R&D

- Firms choose R&D intensity and Poisson rate $n$which costs $\psi(n) = \frac{n^2}{2}$ in units of labor
- There is also a hazard rate h at which followers copy the leaders technology and catch up
- $n_1 = 0$ so need to find n_{-1} and n_0.
- From the value functions we find:

$$\begin{aligned} n_0 &= -h + \sqrt{h^2 + 2\Delta\pi_1} \\ n_{-1} &= -(h + n_0) + \sqrt{h^2 + n_0^2 + 2\Delta\pi_1} \end{aligned}$$

where

Industry Shares and Aggregate Innovation

- Competition produces faster growth in neck-and-neck sectors whereas it slows down growth in unleveled sectors.
- Let μ_1 and μ_0 be the share of unleveled and neck-and-neck industries respectively
- The inflow and outflow of the leveled state have to be equal:

$$\underbrace{\mu_1 \cdot (n_{-1} + h)}_{P(m_{t+1} = 0 | m_t = 1)} = \underbrace{\mu_0 (n_0 + n_0)}_{P(m_{t+1} = 1 | m_t = 0)}$$

- Since $\mu_1 + \mu_0 = 1$ the innovation flow rate will be

$$I = 2\mu_0 n_0 + \mu_1 (n_{-1} + h) = \frac{4 n_0 (n_{-1} + h)}{2 n_0 + n_{-1} + h}$$

Productivity

- The model distinguishes between leveled and unleveled sectors, which depends on leader and follower productivity
- Estimate TFP by running the following fixed-effects regression:

$$\log(y_{it}) = \mu_t + \alpha^k_{SIC} \log k_{it-1} + \alpha^l_{SIC} \log l_{it-1} + \underbrace{\mu_i + \varepsilon_{it}}_{TFP}$$

- Let A_F be the leader's productivity. For some firm $j \neq F$, we define the technological gap with the leader as

$$m_j = \frac{A_F - A_j}{A_F}$$

- Take the average m_j within a industry and define leveled and unleveled industries as those with $\bar{m}_j < 0.5$ and $\bar{m}_j > 0.5$ respectively

Innovation and Profits

- Both surveys only have a one digit SIC identification. Thus differentiate sectors by SIC code, geographic Region and firm Size (Small, Medium and Large)
- From the Innovation Survey determine R&D intensity as the investments in research and development over sales n_i and find the average R&D intensity within a sector
- From the LSF obtain profits for each firm and then the average within each sector

Targeted Moments

- The parameters we estimate are $\theta = (r, \gamma, \varepsilon, h)$
- The paper estimates five moments:

1.	Average R&D intensity in unleveled sectors	:	$\bar{n}_{-1}$
2.	Average R&D intensity in leveled sectors	:	$\bar{n}_0$
3.	Average Profits in unleveled sectors	:	$\bar{\pi}_1$
4.	Ratio of "leveled" to "unleveled" Profits	:	$\frac{\bar{\pi}_0}{\bar{\pi}_1}$
5.	Relative sector shares	:	$\frac{\mu_0}{\mu_1}$

Results - Parameter Estimates

Table: Parameter Estimates

#	Parameter	Description	Value
1.	ε	Extent of collusion	0.22
2.	γ	Size of leading edge innovation	1.03
3.	h	Catch-up rate	0.13
4.	E	Expenditure on each sector	0.96

Results - Moments

Table: Model and Data Moments

#	Moments	Model	Data
1.	Average R&D intensity in unleveled sectors	0.028	0.011
2.	Average R&D intensity in leveled sectors	0.12	0.013
3.	Average Profits in unleveled sectors	0.03	115429
4.	Ratio of "leveled" to "unleveled" Profits	0.22	0.22
5.	Relative sector shares	0.65	5.24

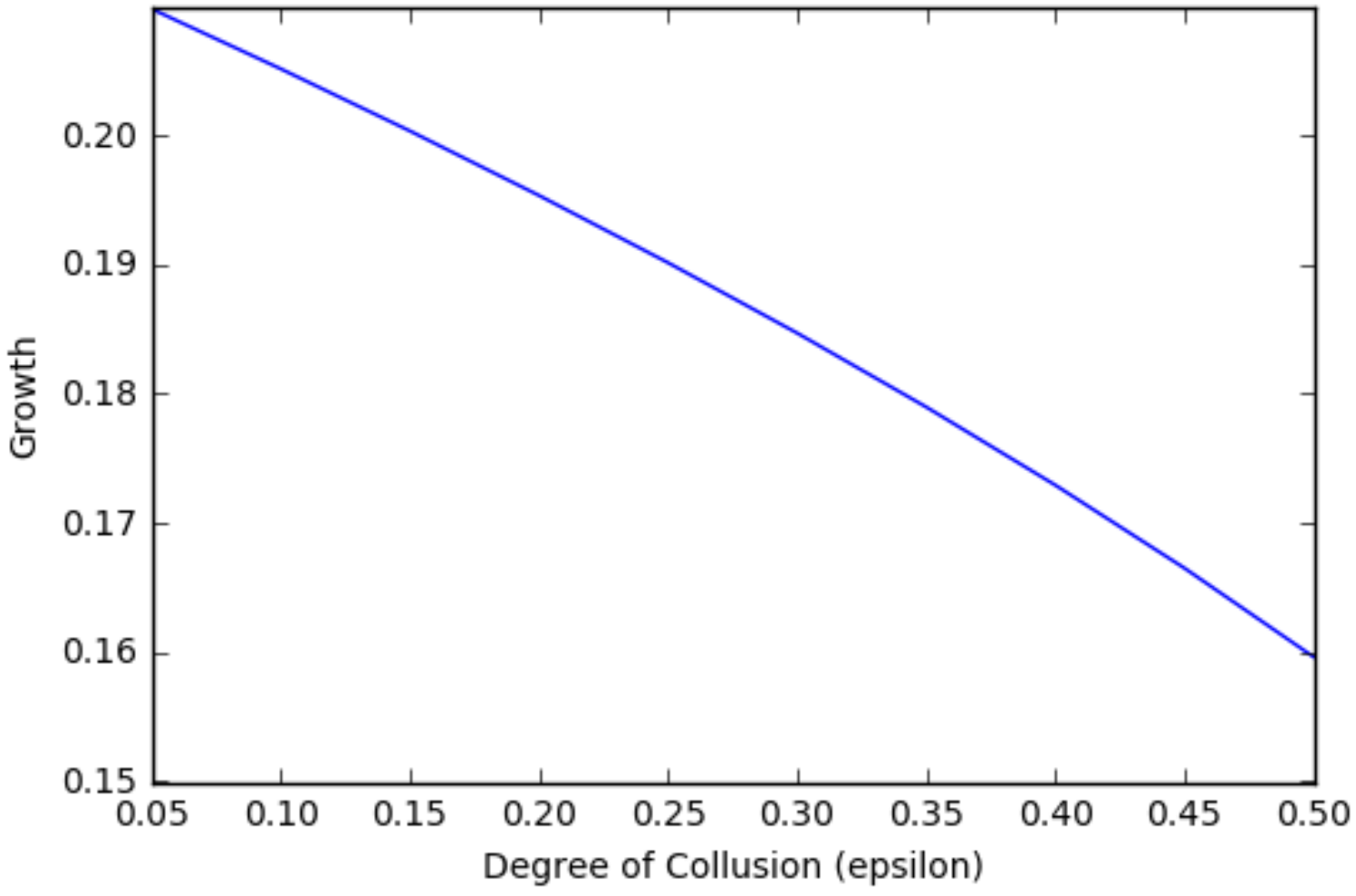
Productivity Growth

- Recall growth is given by

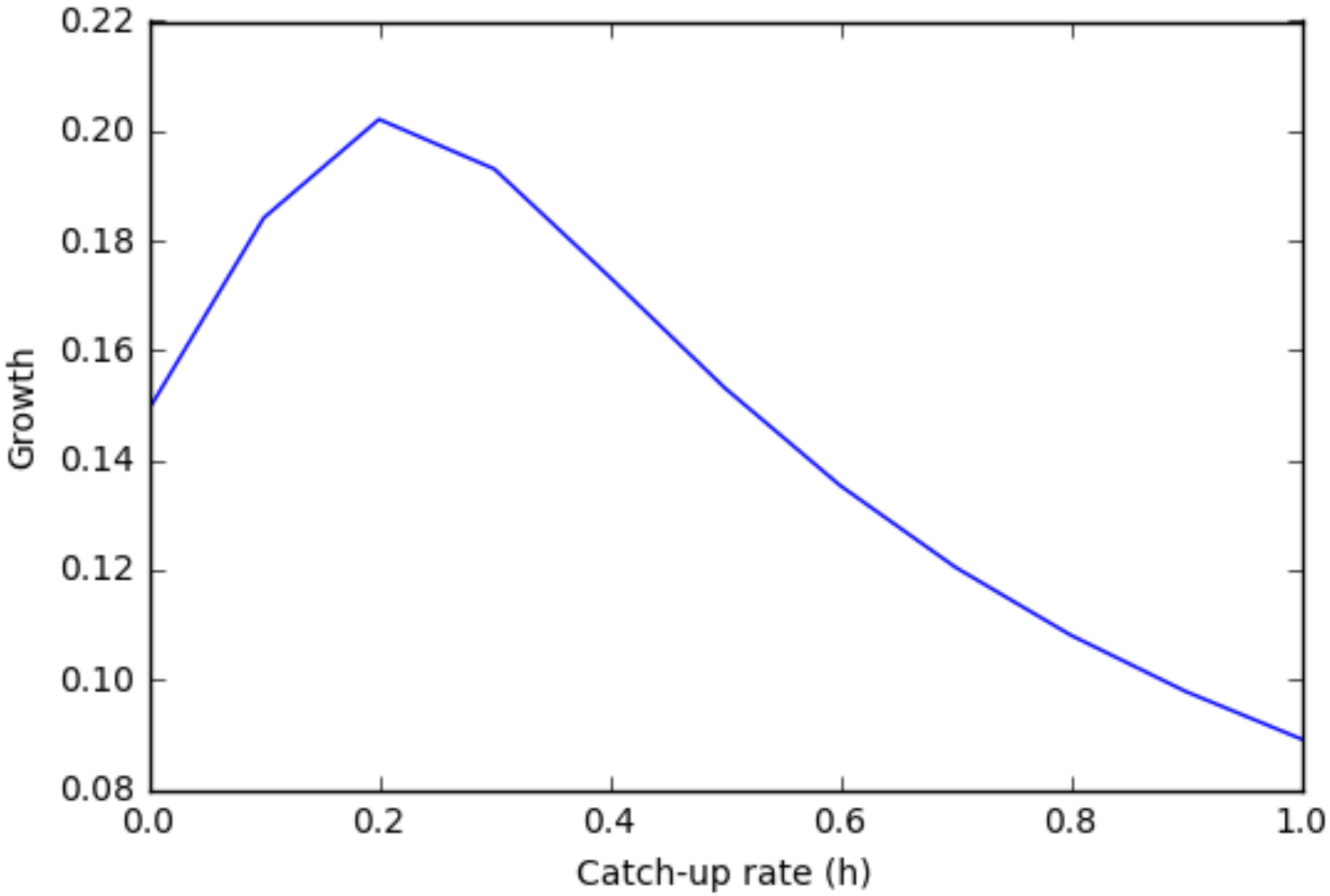
$$I = 2\mu_0 n_0 + \mu_1 (n_{-1} + h)$$

- The estimates produce a growth rate of 19%.
- If we only increase ε to its maximum value $\varepsilon = 0.5$, productivity growth decreases to $g = 16\%$ and if we set it to $\varepsilon = 0$, economic growth increases to $g = 21\%$
- If we only increase h and set it to $h = 1$, growth drops to $g = 0.09$. If $h = 0$, growth still decreases to $g = 14\%$
- As we increase competition (and decrease ε) economic growth increases. However, changes in patent protection (h) are ambigous.

Growth and Competition



Growth and Patent protection



Limits and potential extensions

- Estimation did not match the moments which could lead to further research
- Increasing complexity of the model: theoretical framework requires more dimensions (more then two firms, firm entry and exit, capital...)
- Economic growth in developing countries is determined by physical and human capital accumulation rather than innovation (low R&D)