Theory and Evidence on Corruption and Innovation

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Motivation

Corruption is a serious issue affecting most economies, but particularly those that are "middle income"

Countries in transition (like China) rely just on efficient allocation of physical capital

- need to generate new knowledge and ideas through innovation

Corruption affects allocation of profits amongst firms and hence incentices for innovation

Corruption and Innovation

We propose a theory higher industry concentration results in less innovation

Under the assumption that corruption exacerbates concentration, this yields a theory where corruption lowers innovation

$$\text{Corruption} \quad \longrightarrow \quad \text{Concentration} \quad \longrightarrow \quad \text{(Less) Innovation}$$

Empirical Strategy

The 2012 anticorruption campaign affords a good opportunity to study efforts to reduce corruption

- but many things happened at that time!

Following Gianetti (2017) we exploit industry heterogeneity in prevalence of corrupt activity to generate variation

- industries with more corruption will see larger effect of campaign

Proxy industry corruption with level of entertainment expenses compared to sales

Model Primitives

Fixed industry size with N separate firms

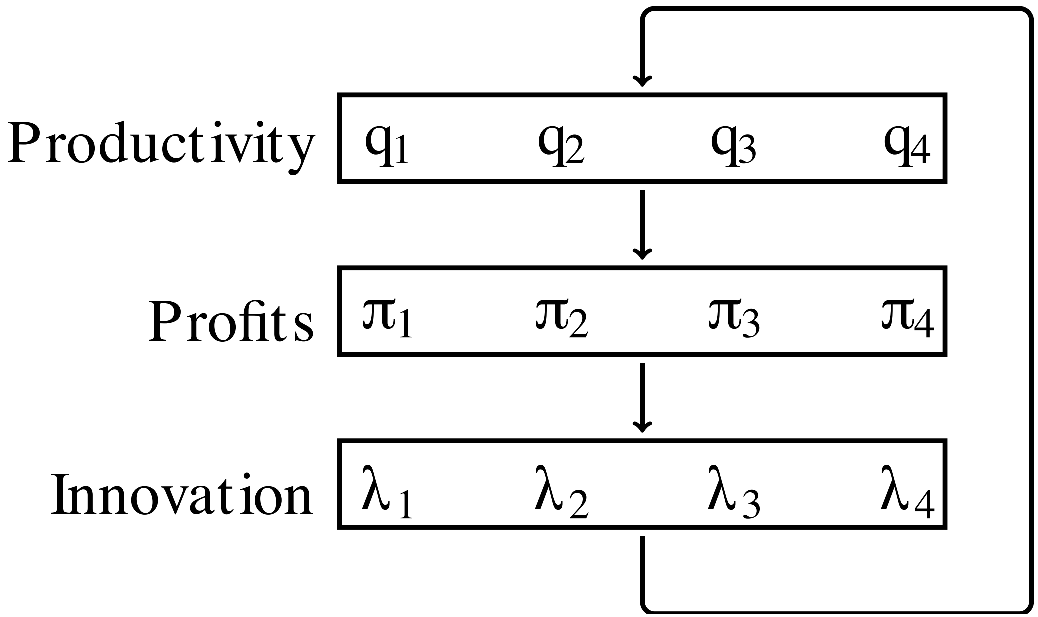
Each firm has a particular productivity/knowledge stock q_i

Firms combine knowledge and labor (Cobb-Douglas) to produce output

- industry's pool of labor is fixed
- labor could stand in for any fixed factor

Firms invest innovation to improve their productivity

Innovation Cycle



Production Decisions

The production function is given by

$$y_i = q_i^{1-\alpha} \ell_i^{\alpha}$$

We assume that firms take output price and wage as given

$$\pi_i = p y_i - w \ell_i$$

Optimal output is then linear in Productivity

$$y_i = q_i \left(\frac{\alpha p}{w} \right)^{\frac{\alpha}{1-\alpha}}$$

Labor Market

Labor market clearing yields the equilibrum wage rate

$$w = \alpha p \left[\sum_i q_i \right]^{1-\alpha} \equiv \alpha p Q^{1-\alpha}$$

Thus profits are also linear in Productivity

$$\pi_i = \frac{(1-\alpha)p}{Q^\alpha} \cdot q_i$$

Other firms' productivities drive up wages, thus cutting into firm profits

Profit Shares

Because of linearity, each firm's share of the industry its relative productivity

$$\frac{\pi_i}{\Pi} = \frac{y_i}{Y} = \frac{q_i}{Q} \equiv s_i$$

where $\Pi = \sum_i \pi_i$ and $Y = \sum_i y_i$

Determining the output price will make this true in absolute terms

Industry Demand

Suppose total output comprises inputs from many industries

$$\log(Z) = \sum_j \log(Y_j)$$

A standard result is that consumers will spend a constant fraction on each Industry

$$Z = P_j Y_j \quad \forall\, j$$

Tullock Contest

In our original notation, this implies

$$p = \frac{Z}{Y} = \frac{Z}{Q^{1-\alpha}}$$

Thus the ultimate profit function is then

$$\pi_i = (1 - \alpha)Z \cdot \frac{q_i}{Q}$$

This functional form is that of the well known **Tullock contest** used in political science

Innovation Incentives

Firms invest continuously in innovation by choosing a proportional **step size** λ_i with cost $d(\lambda_i)$ researcher workers and law of motion

$$\dot{q}_i = \lambda_i q_i$$

This type of cumulative investment technology differentiates knowledge capital from physical capital

Marginal profit incentives

$$q_i \frac{\partial \pi_i}{\partial q_i} = (1-\alpha)Z \cdot \frac{q_i}{Q}\left(1 - \frac{q_i}{Q}\right) = (1-\alpha)Z \cdot s_i(1-s_i)$$

One-shot Model

For intuition, consider setting with short-sighted firms

$$\max_{\lambda_i} \pi_i(q_i(1 + \Delta\lambda_i)); q_{-i}) - \nu\Delta d(\lambda_i)$$

This yields the optimality condition ($\tilde{\nu} = \nu/Z$)

$$\tilde{\nu} d'(\lambda_i) = (1 - \alpha) \cdot s_i\,(1 - s_i)$$

Firm innovation is first increasing, then decreasing after

$$s_i^* = \frac{1}{2}$$

Innovation Rates

Suppose that d is quadratic, so that $d(\lambda) = \frac{d}{2}\lambda^2$

We may be interested in the average innovation rate (number of patents) in a positive sense

$$\bar{\lambda} = \frac{1}{N}\sum_i \lambda_i = \frac{1}{N}\frac{1-\alpha}{\tilde{\nu}d}(1-H)$$

Where H is the Herfindal index of industry concentration (also known as a **diversity index** of order 2)

$$H = \sum_i s_i^2 = D^2$$

Overall Growth

If we are interested in aggregate growth rates

$$g = \frac{\dot{Q}}{Q} = \sum_i s_i \lambda_i = (1 - \alpha)\left(D^2 - D^3\right)$$

Where D^σ is the diversity index of order σ

$$D^\sigma = \sum_i s_i^\sigma$$

In practice g and $\bar{\lambda}$ are highly correlated

Market for Researchers

New researchers are hard to train, so $\tilde{\nu}$ should equilibrate research labor market

$$\tilde{\nu} = \frac{1-\alpha}{\sqrt{2d}} \sum_j \left[D_j^2 - 2D_j^3 + D_j^4\right]$$

Question becomes how to allocate researchers across industries

- those with higher concentration will get fewer researchers

Infinite Horizon

Model is more complete but less tractible with forward looking firms

Corruption

What form does corruption take? We model it as a direct shifter of the productivity: $q_i \longrightarrow q_i' = e_i q_i$

- this can be shown to be equivalent to an input cost subsidy

Large firms get more favor from officals so the effective productivity is

$$e_i = q_i^{\delta} \quad \Rightarrow \quad q_i' = q_i^{1+\delta}$$

Effect of Corruption

The profit is the firm is now

$$\pi_i' = (1-\alpha)Z\frac{q_i^{1+\delta}}{\sum_j q_j^{1+\delta}} = (1-\alpha)Zs_i'$$

Under the existing assumptions, the innovation rate is

$$\lambda_i = \frac{(1-\alpha)(1+\delta)}{\tilde{\nu}d} s_i'(1-s_i')$$

And the average innovation rate is

$$\bar{\lambda} = \frac{1}{N}\frac{(1-\alpha)(1+\delta)}{\tilde{\nu}d}\left(1-H'\right)$$

Data Sources

Chinese firms from Annual Tax Survey, 2007-2015

- balance sheet: sales, cost, profits
- R&D investment
- business entertainment expenses
- various taxes paid

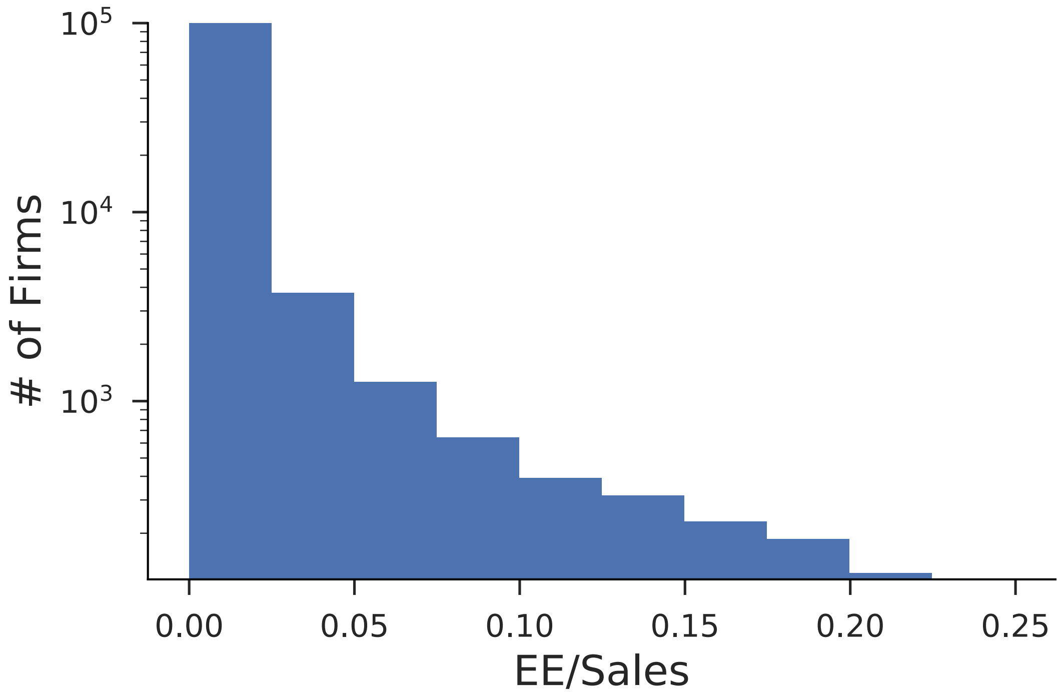
Chinese patent data from SIPO, 1985-2016

- merged by firm name with firm level data

Industrial R&D investment in US by industry, 2007-2014

Entertainment Expenses

$$\text{EE Share} = \frac{\text{EE Spending}}{\text{Total Sales}} \qquad \text{Average} = 0.9\%$$



Anticorruption

Anecdotal evidence on effect on entertainment

Patent Regressions

Patent count data is both discrete and highly non-normal, so we use GLM with Poisson kernel

$$y_i \sim \text{Poisson}(\mu_i) \qquad \log(\mu_i) = \beta \cdot \mathbf{X_i}$$

Alternative specifications such as Negative Binomial and/or zero inflation generally yield qualitatively similar results

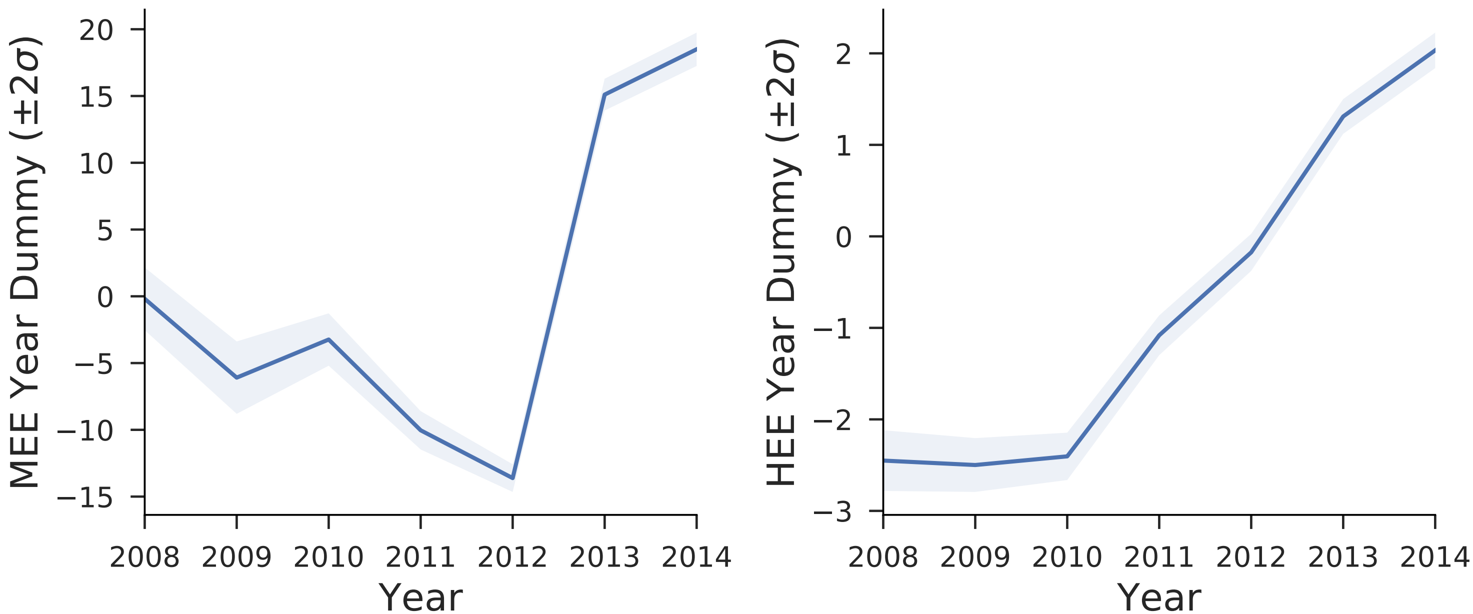
Diff-in-diff

Across industry: median/Herfindahl industry EE spending
Across time: pre/post 2012 anticorruption campaign

	Log Poisson Rate
Log Sales	0.3918*** (0.0013)
Post x Median EE/Sales	26.7869*** (0.5259)
Post x EE Herfindahl	3.1091*** (0.0873)
Controls	Yes
N	75172

Year Dummies

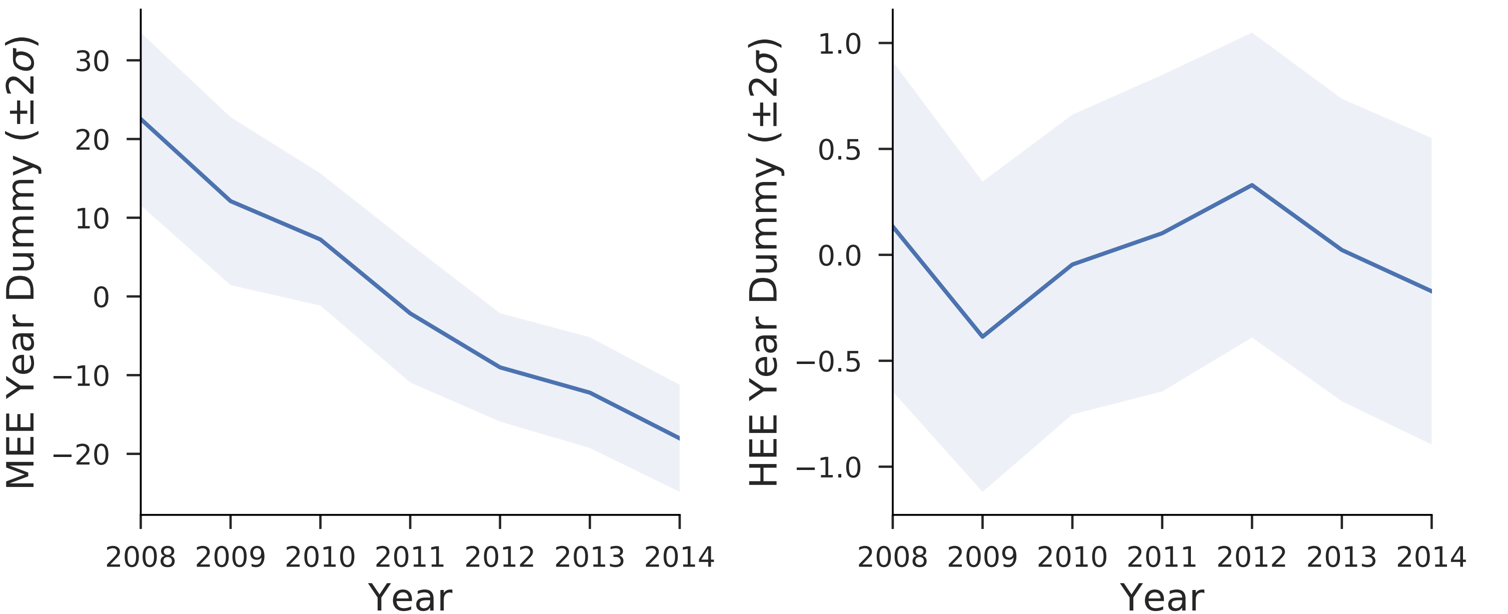
Mean industry EE share interaction shows a strong jump in 2013, after the 2012 campaign



Herfindahl EE share shows a positive trend, but is gradual and starts before 2012

R&D Investment

Secular trend in R&D investment rates, but no clear relation to pre/post anticorruption



May be that time-scale of R&D projects is too long

Realized Enforcement (Patents)

We can also look at *realized* anticorruption enforcement by tracking the number crimes per public official at the provincial level

	Log Poisson Rate
Log Sales	0.3926*** (0.0014)
Criminal Convictions	0.0336*** (0.0011)
Crime x Median EE/Sales	0.1264** (0.0517)
Crime x EE Herfindahl	0.1565*** (0.0068)
Controls	Yes

Realized Enforcement (R&D)

Now we see a positive effect for patent as well as R&D investment

	Log R&D Spending
Log Sales	0.5273*** (0.0045)
Criminal Convictions	0.0096*** (0.0036)
Crime x Median EE/Sales	0.7099*** (0.2426)
Crime x EE Herfindahl	0.0071 (0.0270)
Controls	Yes

Protection Substitution

Evidence on R&D spending is somewhat mixed

One interpretation is firms switching from informal modes of protection (corruption) to formal ones (patenting)

Benefit would be that protection rewards new technology rather than connections

- may encourage knowledge diffusion through patents

However, connected firms may understand institutions better (Ang and Jia, 2014)

Possible Extensions

Consider entry/exit margin in addition to concentration as it relates to anticorruption (would need panel)

Examine implications of switching to formal modes of protection from competition (more or less secrecy?)

Investigate efficiency considerations theoretically, including knowledge diffusion dimension

Thanks!