# Growing through Competition: The Reduction of Entry Barriers among Chinese Manufacturing Firms

Helu Jiang[1] Yu Zheng[2] Lijun Zhu[3]

[1]Shanghai University of Finance and Economics

[2]Queen Mary University of London and CEPR

[3]Peking University

ABFER
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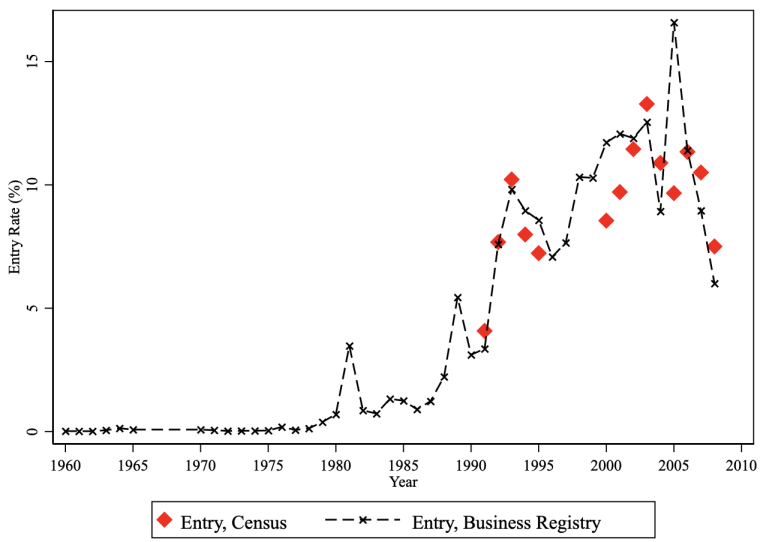
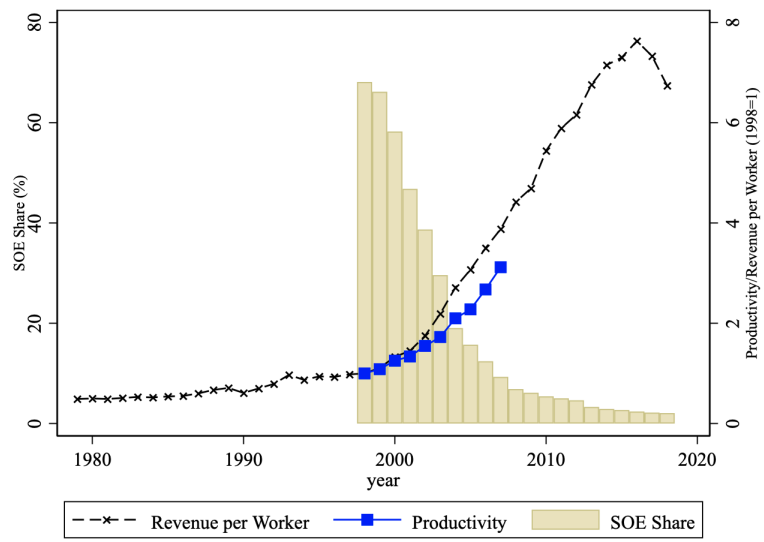
# Motivation

- Firm entry is a major contributor to Chinese manufacturing productivity across time and space (Brandt el al., 2012, 2020)
  - net entry accounts for over 2/3 of TFP growth over 1998-2007
- Reductions of entry barrier are achieved by waves of economic reforms, which were initiated in 1978 and accelerated after 1992 (Hsieh and Song, 2015)
  - (predominantly) private entrants were gradually allowed in, which brought competition to sectors previously dominated by few state players
- The pro-competitive and pro-growth effects of firm entry appear to be an important channel for China's economic reforms to take effect
- Put "competition" back to the discussion by adopting a framework of endogenous productivity and market structure with heterogeneous firms and sectors

# Motivation: Aggregates over Time

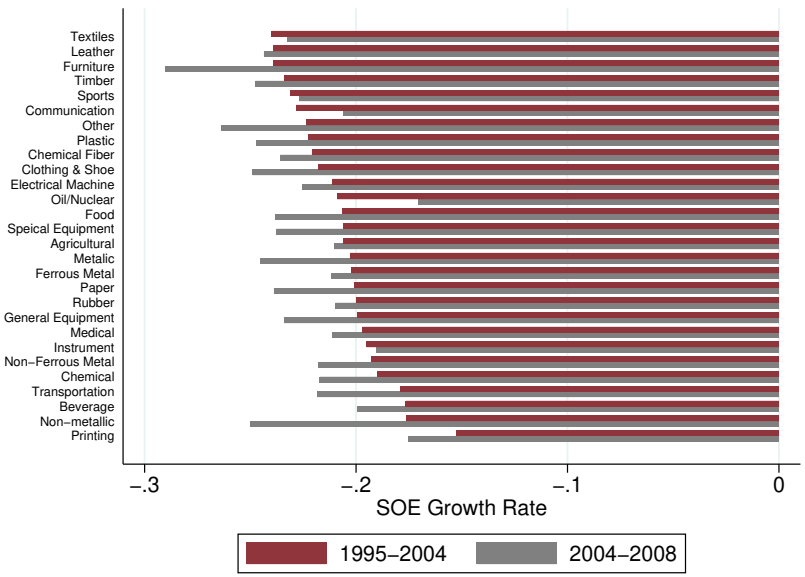
- Aggregate Entry Rates in the Chinese Industrial Sector grew from 1960 to 2008
- Growth of real revenue per worker (productivity) accelerated:
  - 2.2% (1980s), 8.47% (1990s), 15.27% (2000s)
- State share in the industrial sector dwindled

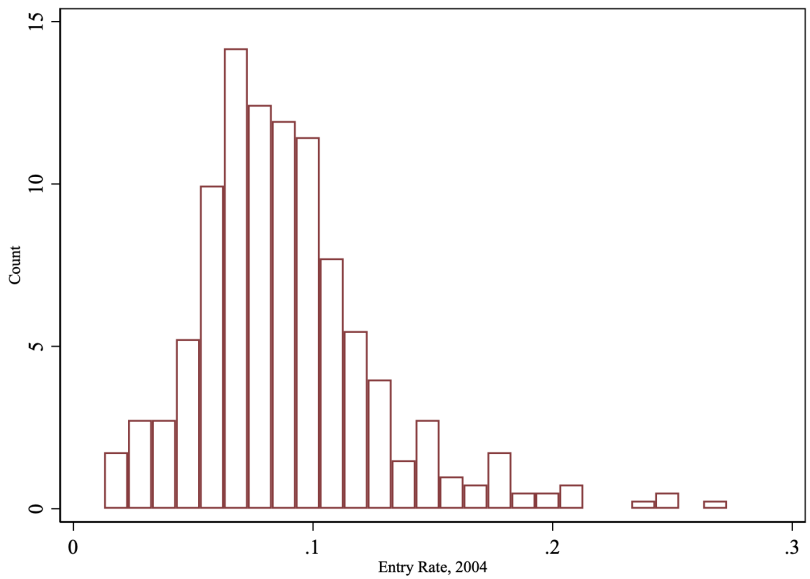


# Motivation: Cross-sectional Variations

- Reduction of SOE shares varies across (and also within) industries
- Wide dispersion of entry rates across industries even in 2004



# What We Do

- We provide empirical evidence from firm-level data on the pro-growth and pro-competitive effects of entry
- We embed entry into an endogenous growth model with step-by-step innovation (Aghion et al. 2001, Akcigit & Ates, 2019)
  - in each industry, there is a leader, a follower and a potential entrant
  - add ex ante *firm-level heterogeneity* (in innovation efficiency) and *sector-level heterogeneity* (in entry barrier)
  - identify four channels through which entry affects growth, in particular a *pro-competitive* effect
  - Innovation is broadly interpreted to be any costly measure to increase productivity
- We calibrate the model to 2004-7 Chinese manufacturing firm data, exploiting cross-sectional variations in entry barrier in 2004
- We isolate the change in aggregate entry from 1995 to 2004 induced by SOE reforms and assess counterfactually what the growth rate would have been in 2004, had entry barriers remained as high as in 1995

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# What We Find

- Using the calibrated model, the 1.9 percentage point difference in growth between the low- and high-entry barrier sectors is mainly driven by
  - the replacement effect (aka selection): $41\%$
  - the pro-competitive effect: $59\%$

- Recalibrating the model entry barrier to target a counterfactual entry rate (consistent with 1995 SOE presence) yields
  - a counterfactual growth rate of $7.57\%$ (compared to the actual $9\%$)
    - $9 - 7.57$ or $1.43$ pp $\approx 16\%$ of the 2004-7 level of growth
    - the historical growth differential between 1991-5 and 2004-7 is roughly $3.4$ pp. So $1.43$ accounts for $42\%$ of the historical growth differential
  - of the $1.43$ pp, $39\%$ is due to replacement effect
  - $57\%$ due to pro-competitive effect

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# Related Literature

- literature investigating the mechanisms behind China's economic growth
  - expansion of the non-state sector: Zhu (2012); Hsieh and Song (2015)
  - reduction of entry barriers: Brandt et al., (2012, 2020)
  - the improved allocation of capital: Song et al., (2011)
  - reduction in inefficiencies in output and factor markets: Hsieh and Klenow (2009); Cheremukhin et al., (2017)
- Schumpeterian-growth models with step by step innovation: Aghion et al., (2001, 2005); Akcigit and Ates (2019)
- the role of entry barrier in explaining economic growth in developing countries: Parente and Prescott (1999); Aghion et al., (2005); Herrendorf and Teixeira (2011); Asturias et al., (2019)

# Empirical Evidence

Pro-competitive Effects of Firm Entry in the Chinese Manufacturing Sector

# Data

- Chinese Industrial Census (1995, 2004, and 2008)
  - includes all active industrial firms
  - contains information on firm-level revenue, employment, ownership, etc.
- Annual Surveys of Industrial Enterprises (1998-2007)
  - conducted by the National Bureau of Statistics
  - includes all "above-scale" industrial firms (sales $>$ 5 mil RMB) + SOE
  - represents about 90% of gross output in manufacturing
  - contains information on firm-level output, employment, investment, intermediate goods expenditure, total wage bill, capital ownership structure, etc.

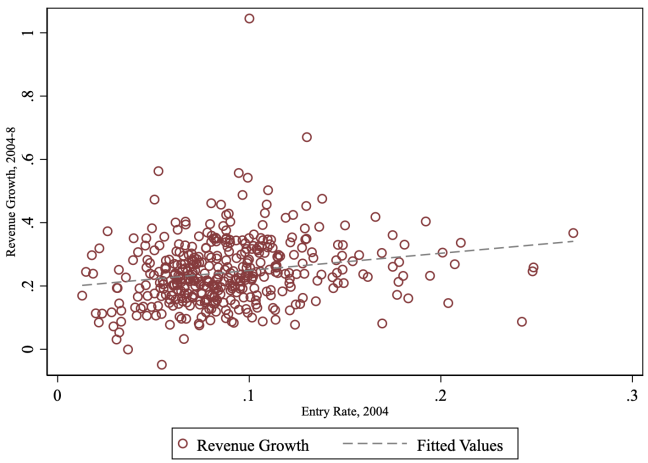
We focus on manufacturing.

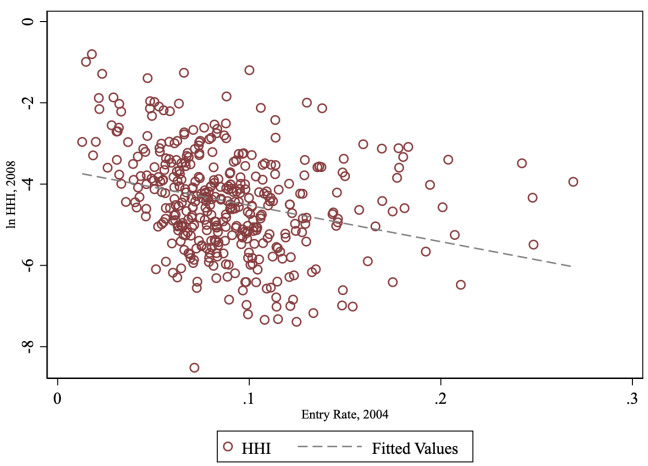
# Variable Construction

- Entry rates from Census
  - at 4-digit CIC industry level
  - weighted by employment
- Competition from Census
  - HHI at 4-digit CIC industry level
- Productivity from ASIE Productivity estimation
  - modified two-stage control function approach (Levinsohn and Petrin, 2003; De Loecker and Warzynski, 2012)
  - drift term is a function of current-period capital, last-period HHI, and current-period SOE status
  - estimate a value-added Cobb-Douglas production function at 2-digit CIC industry level with GMM

Summary statistics

# Empirical Findings: Industry-Level Evidence, Census 2004 and 2008




| | Real Revenue Growth | | | log HHI | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| average entry rate | 0.870*** | 0.571*** | 0.544*** | -5.513*** | -4.138** | -2.990* |
| | (5.27) | (3.79) | (3.91) | (-3.57) | (-2.70) | (-1.96) |
| 2004 SOE share | 0.250 | 0.286* | 0.263* | 2.052* | 1.885* | 2.859** |
| | (1.64) | (2.05) | (2.02) | (1.93) | (1.72) | (2.63) |
| 2004 number of firms (million) | 0.186 | -0.744 | -0.842 | -122.6*** | -118.3*** | -114.2*** |
| | (0.24) | (-1.02) | (-1.16) | (-6.48) | (-6.61) | (-6.44) |
| 2004 log industry employment | | -0.0496*** | -0.0350* | | 0.228** | -0.388*** |
| | | (-6.83) | (-2.04) | | (2.57) | (-2.84) |
| 2004 log industry revenue | | | -0.0122 | | | 0.515*** |
| | | | (-0.97) | | | (5.09) |
| $R^2$ | 0.200 | 0.260 | 0.262 | 0.525 | 0.534 | 0.563 |
| Observations | 400 | 400 | 400 | 400 | 400 | 400 |

$t$ statistics in parentheses

2-digit CIC industry fixed effects controlled; standard errors clustered at 2-digit industry level

$^{*}\ p < 0.10,\ ^{**}\ p < 0.05,\ ^{***}\ p < 0.01$

Different ownership types HHI change

# Empirical Findings: Firm-Level Evidence, ASIE

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| average entry rate | | | 0.468*** | 0.444** |
| | | | (6.32) | (2.09) |
| firm age | -0.00323*** | -0.00355*** | -0.000489 | -0.00141* |
| | (-21.18) | (-7.60) | (-1.11) | (-2.01) |
| average entry rate × firm age | | | -0.0326*** | -0.0251*** |
| | | | (-6.58) | (-3.93) |
| $R^2$ | 0.007 | 0.011 | 0.007 | 0.011 |
| 2-digit industry F.E. | No | Yes | No | Yes |
| 2-digit industry clustered S.E. | No | Yes | No | Yes |
| Observations | 314032 | 314032 | 314032 | 314032 |

$t$ statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Controls: employment, capital, export status.

Exporting firms | Age pattern | Other output measure | Interaction

# Interim Summary

- Rapid productivity growth occurred from 1998 to 2007
- Entry grew at the same time from 1995 to 2004
- Cross-sectional evidence suggests
  - positive correlation between entry and productivity growth
  - positive correlation between entry and competition

# Model: Environment

We build on the endogenous growth model with step-by-step innovation as in Aghion, Harris, Howitt and Vickers (2001, ReStud)

# Model: Households

- An infinitely lived representative household

$$\max \int_0^\infty e^{-\rho t} \left[\log Y(t) - L(t)\right] dt$$

where

$$\log Y(t) = \int_0^\zeta \log y_\nu(t) d\nu + \int_\zeta^1 \log y_\nu(t) d\nu$$

- Sector $1$ for $[0, \zeta]$, and $2$ for $(\zeta, 1]$; Sector 2 has a lower 'entry barrier'
- Use labor as numeraire and normalize wage to $1 \rightarrow 1 = P(t)Y(t) = p_\nu(t)y_\nu(t)$

# Model: Firms

- Each industry consists of two firms and the industry output is

$$y_\nu(t) = \left[ y_{\nu,1}(t)^\delta + y_{\nu,2}(t)^\delta \right]^{1/\delta}$$

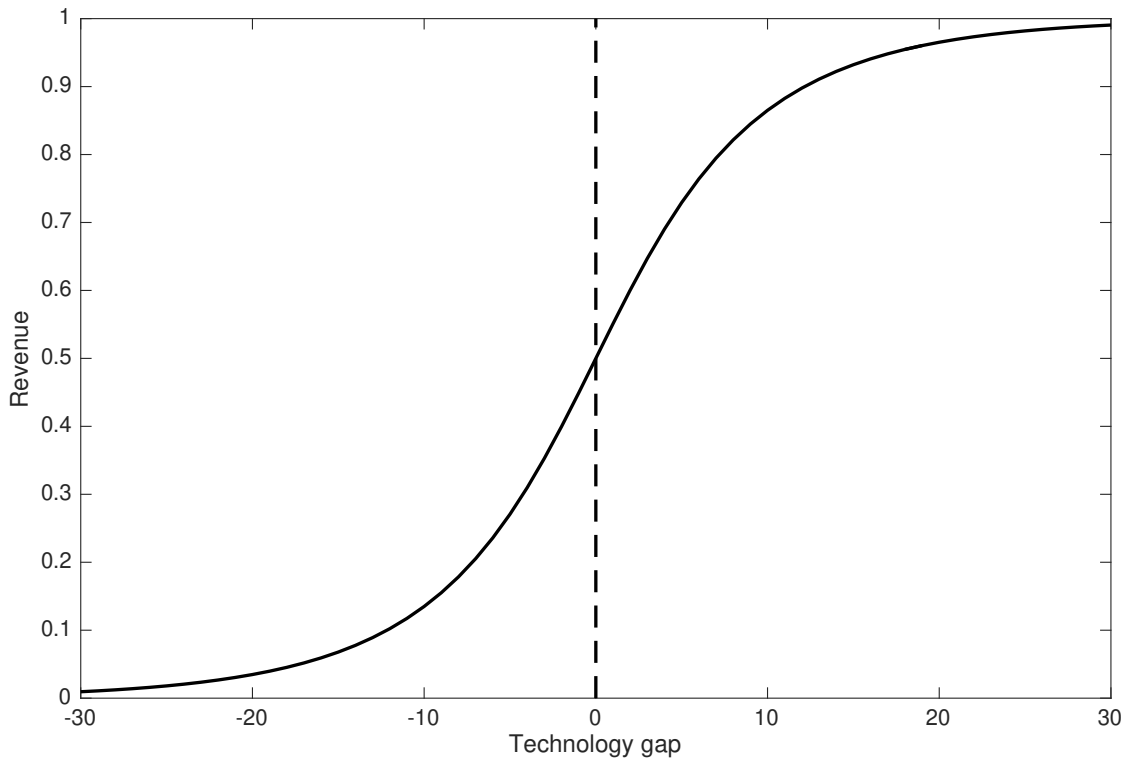
- Each firm $\iota \in \{1, 2\}$, which is on the $n_\iota$th rung of a quality ladder produces using labor

$$y_\iota = \lambda^{n_\iota} l_\iota$$

  with the unit cost $c_\iota = \lambda^{-n_\iota}$.
- The two firms engage in Bertrand competition, $\max_{p_\iota}(p_\iota - c_\iota)y_\iota$
- It can be shown that the revenue and profit of firm $\iota$ are functions of its technological gap relative to its opponent Derivations

# Model: Product Market

- The revenue (and profit) is a logistic function of the technology gap between the two firms.




An industry with 0 gap is neck-and-neck, otherwise is unleveled.

Logistic in data

# Model: Innovation

- Firms engage in costly innovation to advance on the quality ladder
  - leaders in unleveled ind. and firms in neck-and-neck ind. move 1 step
  - followers in unleveled ind. w.p. $1-\phi$ move 1 step, w.p. $\phi$ catch up with leader
- Innovation cost: $\frac{\beta}{\alpha}x^{\alpha}$ where $x$ is the success rate and $\alpha > 1$
- Firms are of two types: high/low $\beta_h < \beta_l$.
- Firms enter as high type; high $\rightarrow$ low at rate $\sigma$ (Acemoglu et al.'18) Age

$$\sigma_j = \begin{cases} \sigma, & \text{if } j = h; \\ 0, & \text{if } j = l. \end{cases}$$

- Entrant has a disadvantage in innovation $\tau_s, s = 1, 2$ multiplied to cost
  - "entry barrier"
  - In an unleveled industry, a successful entrant replaces the follower
  - In a neck-and-neck industry, a successful entrant replaces either incumbent with equal probability

# Model: Value Functions in Unleveled Industries

VFs neck-and-neck

State variables: $(i, j, n, s)$

A leader's value

Follower

$$rV_{ij}(n) = \max_{x_{ij}(n)} \underbrace{\pi(n)}_{\text{profit}} - \underbrace{\beta_i \frac{x_{ij}(n)^\alpha}{\alpha}}_{\text{R\&D cost}} + \underbrace{x_{ij}(n)[V_{ij}(n+1) - V_{ij}(n)]}_{\text{successful innovation}} + \underbrace{\sigma_i[V_{lj}(n) - V_{ij}(n)]}_{\text{change of self-type}}$$
$$+ \underbrace{\sigma_j[V_{il}(n) - V_{ij}(n)]}_{\text{change of follower type}} + \underbrace{\overline{x}_{ij}(n)\{\phi[V^i_{ij}(0) - V_{ij}(n)] + (1-\phi)[V_{ij}(n-1) - V_{ij}(n)]\}}_{\text{successful innovation by follower}}$$
$$+ \underbrace{x^e_{ij}(n)\{\phi[V^i_{ih}(0) - V_{ij}(n)] + (1-\phi)[V_{ih}(n-1) - V_{ij}(n)]\}}_{\text{successful innovation by entrant}}$$

An entrant's value:

$$rV^e_{ij}(n) = \max_{x^e_{ij}(n)} -\tau_s \beta_h \frac{x^e_{ij}(n)^\alpha}{\alpha} + x^e_{ij}(n)[\phi V^h_{hi}(0) + (1-\phi)\overline{V}_{ih}(n-1)].$$

# Stationary Equilibrium

- Focus on the balanced growth path of the model economy. Denote $\mu_s(\psi, n)$ the fraction of industries with type $\psi = (H,H),(H,L),(L,H),(L,L)$, gap $n \geq 0$ in sector $s, s = 1, 2$.

$$\sum_s \sum_\psi \sum_n \mu_s(\psi, n) = 1.$$

- As the entry barrier para. is fixed across industries and over time,

$$\sum_\psi \sum_n \mu_1(\psi, n) = \zeta, \quad \sum_\psi \sum_n \mu_2(\psi, n) = 1 - \zeta$$

- Inflow and outflow from any industry $(\psi, n, s)$ balances out.

# Aggregate Growth

- The aggregate growth rate in the stationary equilibrium equals the sum of growth rates in the two sectors

$$g = g_1 + g_2$$

- The growth rate in sector $s, s = 1, 2$, is

$$g_s \equiv \frac{d \ln Y_s}{dt} = \ln \lambda * \left[ \sum_{\psi} \sum_{n \geq 1} \mu_s(\psi, n) x_s(\psi, n) + \sum_{\psi} \mu_s(\psi, 0) \left[ x_s^1(\psi, 0) + x_s^2(\psi, 0) + x_s^e(\psi, 0) \right] \right]$$

- The aggregate growth rate: average of leader's productivity growth rates for all unleveled industries and average productivity rates for all incumbent firms and entrants in neck-and-neck industries

# QUANTITATIVE ANALYSIS

1. Calibration
2. Decomposition of Growth Rates between Sectors
3. Counterfactual Exercise: Entry Barriers and SOE Reform

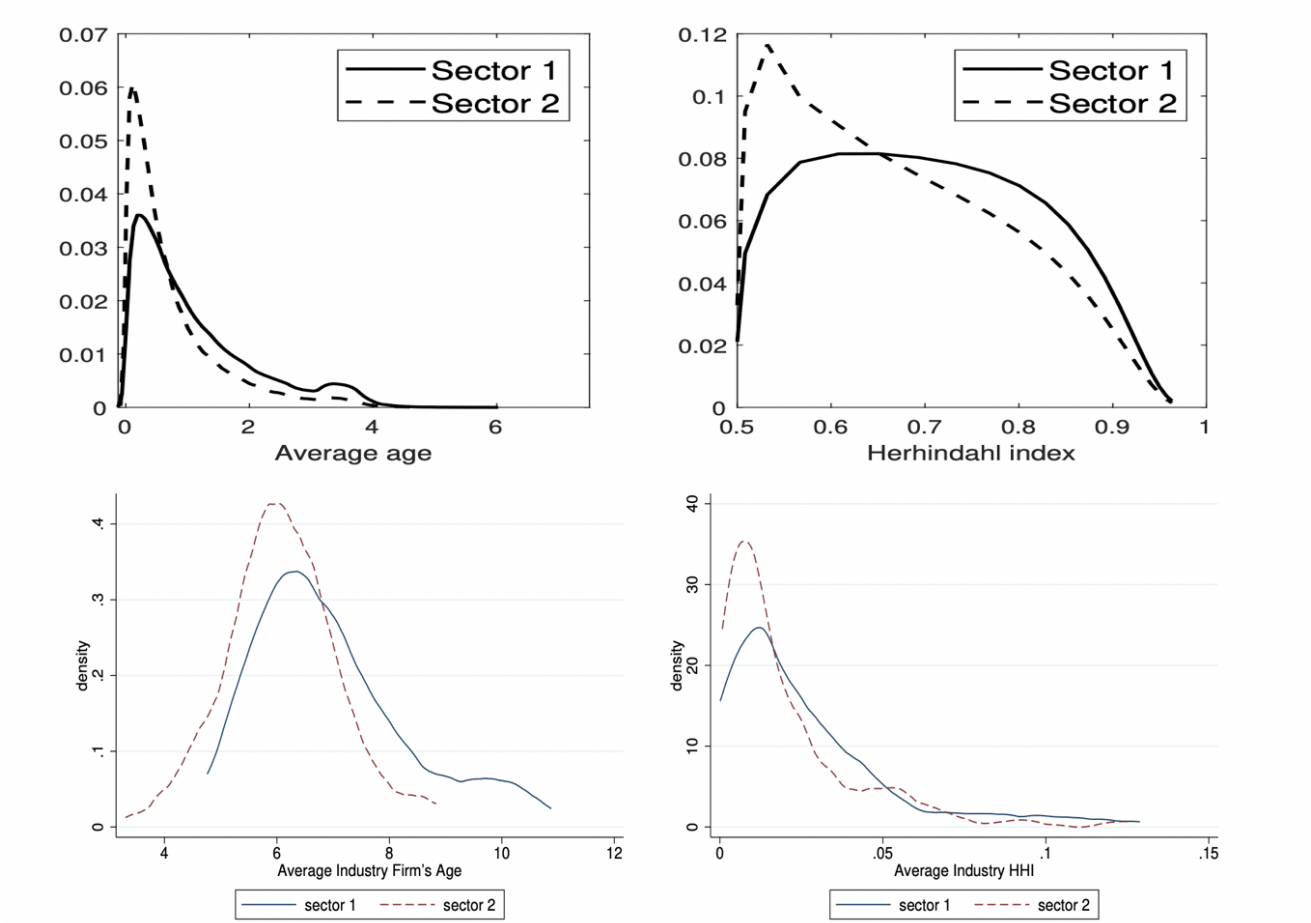
# Calibration

- The model has 11 parameters: $\{\rho, \zeta, \alpha, \beta_h, \beta_l, \tau_1, \tau_2, \sigma, \delta, \phi, \lambda\}$
- It is calibrated to Chinese manufacturing sector 2004-7: Sector 1 consists of all 4-digit industries below the median entry rate in the corresponding 2-digit industries in 2004

| Para. | Description | Value | Moment | Data | Model |
|---|---|---|---|---|---|
| *externally calibrated* | | | | | |
| $\rho$ | discount rate | 0.03 | | | |
| $\alpha$ | inverse of innovation elasticity | 2 | | | |
| *internally calibrated* | | | | | |
| $\zeta$ | size of sector 1 | 0.5 | size of sector 1 | 0.500 | 0.500 |
| $\beta_h$ | innovation cost of high type firms | 0.64 | growth rate of young firms | 0.139 | 0.109 |
| $\beta_l$ | innovation cost of low type firms | 1.63 | growth rate of old firms | 0.066 | 0.047 |
| $\tau_1$ | entry cost in sector 1 | 2.43 | entry rate in sector 1 | 0.090 | 0.090 |
| $\tau_2$ | entry cost in sector 2 | 1.11 | entry rate in sector 2 | 0.120 | 0.143 |
| $\sigma$ | high-to-low type transition rate | 0.19 | large-to-small transition prob | 0.066 | 0.044 |
| $\delta$ | elasticity of substitution within industry | 0.73 | unweighted mean of LS | 0.500 | 0.502 |
| $\phi$ | probability of drastic innovation | 0.11 | prob of remaining small for entrants | 0.625 | 0.699 |
| $\lambda$ | quality step | 1.23 | aggregate growth rate | 0.090 | 0.090 |

# Model Performance: Sector Heterogeneity in Untargeted Observables

Untargeted distributions of age and HHI indicate the source of the difference in growth across sectors: $8.02\%$ vs. $9.98\%$



# Growth Differential Decomposition

- Formally, decompose the growth differential into four components. Recall for $s = 1, 2$ ($\psi$: type configuration of a leader-follower pair)

$$g_s = \ln \lambda \sum_{\psi} \mu_s(\psi, 0) x_s^e(\psi, 0) + \ln \lambda \sum_{\psi} \sum_{n} \mu_s(\psi, n) x_s^L(\psi, n)$$

- The effect of lower entry barrier on growth ($\tilde{\mu}$ : marginal distr.)

$$g_2 - g_1 \approx$$

$$\underbrace{\sum_{\psi} \mu_1(\psi, 0)[x_2^e(\psi, 0) - x_1^e(\psi, 0)] \ln \lambda}_{\textit{direct effect}} + \underbrace{\sum_{\psi} \sum_{n} \mu_1(\psi, n)[x_2(\psi, n) - x_1(\psi, n)] \ln \lambda}_{\textit{Schumpeterian effect}}$$

$$+ \underbrace{\sum_{\psi} \sum_{n} x_1(\psi, n)[f_2(\psi|n) - f_1(\psi|n)] \tilde{\mu}_1(n) \ln \lambda}_{\textit{replacement effect}}$$

$$+ \underbrace{\sum_{\psi} \sum_{n} x_1(\psi, n)[\tilde{\mu}_2(n) - \tilde{\mu}_1(n)] f_2(\psi|n) \ln \lambda}_{\textit{pro-competitive effect}} .$$

# Growth Differential Decomposition

- Decomposition of Growth Rate Differences

| | growth rate | direct | Schumpterian | replacement | pro-competitive |
|---|---|---|---|---|---|
| S2-S1 | 0.019 | 0.002 | -0.002 | 0.0087 | 0.0126 |
| % | | 9.39% | -9.39% | 40.85% | 59.15% |

- The replacement effect is reminiscent of the selection effect in the literature
- The pro-competitive effect is new: only operative in our type of model

Replacement effect Pro-competitive effect

# Quantifying the Contribution to Aggregate Growth Over Time

- Entry rate increased from the 1995 to 2004 Census at the same time as SOE shares declined
  - Wave of privatisation peaked around 1998-2002
- Isolate the increase in entry attributed to the reduction in SOE presence:
  - Pool 1995, 2004 and 2008 Census and regress entry on SOE share controlling for industry FE
  - Use the predicted entry in 1995 to construct the targeted entry rate in the counterfactual
- Recalibrate the model entry barriers $\tau_1 = \tau_2 = \tau^{cf}$ to target the counterfactual entry rate in both sectors

SOE reform Estimates Age & Entry by Sectors

# Quantifying the Contribution to Aggregate Growth Over Time

- Growth rate reduces from $9\%$ to $7.57\%$
  - Policy induced reduction in entry barrier over 1995-2004 accounts for $15.9\%$ of aggregate growth in 2004-7 or about $42\%$ of the growth rate difference between 1991-5 and 2004-7
- Decomposing the growth differential yields

| $\Delta$ growth rate | direct | Schumpterian | replacement | pro-competitive |
|---|---|---|---|---|
| 0.0143 | 0.0017 | -0.001 | 0.0060 | 0.0088 |
| – | 10.97% | -6.45% | 38.71% | 56.78% |

- Again the dominant force behind the gain in growth is the *pro-competitive effect*

Age & HHI distributions

# Conclusion

- We revisit the narrative that gradual economic reform in China removed hurdles to enter previously state-dominated industries, unleashed unprecedented competition and achieved remarkable growth (McMillan and Naughton, 1992).
- We build a model of endogenous productivity and market structure with heterogenous firms and sectors, where entry affects growth through, in particular, a *pro-competitive* effect.
- We assess that the reduction of entry barriers due to policy from 1995-2004 explains $42\%$ of the growth differential between 1991-5 and 2004-7, where $57\%$ of the gain is due to the pro-competitive effect.
- Entry barrier is only one form of anti-competitive measure. Rigid labor market, unequal access to credit, biased courts,... can all hinder competition and growth. We leave them for future research.

## Estimation of Productivity and Markup back

- The benchmark estimates of firm-level productivity and markup follows a modified LP approach: log value added $y_{it}$:

$$y_{it} = \beta_0 + \beta_l l_{it} + \beta_k k_{it} + \omega_{it} + \epsilon_{it},$$

where the persistent productivity shock $\omega_{it}$ follows an random walk:

$$\omega_{it} = \omega_{it-1} + \delta_0 + \delta_k k_{it} + \delta_z z_{it} + \delta_h h_{it-1} + \xi_{it}, \tag{1}$$

- The persistent productivity shock is inferred from material demand:

$$m_{it} = f(\omega_{it}, k_{it}, z_{it}) \Rightarrow \omega_{it} = h(m_{it}, k_{it}, z_{it}),$$

- GMM with two moment conditions: $\zeta_{it}$ orthogonal to $l_{i,t-1}$ and $k_{it}$.
- Separate productivity from markup (De Loecker and Warzynski, 2012)
- Robustness checks using LP but exogenous growth, different assumptions on the drift, balanced panel

# Summary Statistics back

| | Census Sample | | |
|---|---|---|---|
| | 1995 | 2004 | 2008 |
| Age | 12.30 | 6.57 | 6.40 |
| | (12.93) | (8.22) | (6.95) |
| SOE (%) | 89.34 | 12.03 | 4.21 |
| | (30.86) | (32.53) | (20.07) |
| Revenue (thousand) | 10,865.85 | 14,619.28 | 23,823.97 |
| | (126,402.74) | (259,951.13) | (443,324.12) |
| Employment (persons) | 164.25 | 65.57 | 58.21 |
| | (860.51) | (344.67) | (372.90) |
| Number of firms per industry-year | | 82,695.58 | |
| | | (56,069.66) | |
| Number of industries | | 29 | |
| Number of industry-year observations | | 87 | |
| | ASIE Sample, Selected Years | | |
| | 1998 | 2002 | 2007 |
| Age | 15.80 | 14.13 | 10.53 |
| | (13.80) | (12.51) | (9.81) |
| SOE (%) | 28.77 | 13.37 | 3.44 |
| | (45.27) | (34.03) | (18.23) |
| Value added (thousand) | 7,827.91 | 10,194.01 | 14,804.44 |
| | (17,964.91) | (21,845.76) | (31,296.14) |
| Employment (persons) | 273.02 | 218.06 | 161.50 |
| | (469.37) | (328.77) | (246.32) |
| Productivity | 1.00 | 1.42 | 2.61 |
| | (0.87) | (1.16) | (2.24) |
| Number of firms per industry-year | | 7,301.66 | |
| | | (4,427.27) | |
| Number of industries | | 26 | |
| Number of industry-year observations | | 260 | |

## Results Driven by Private Firms back

Table: Share of New Entrants by Ownership Types

| | 1995 | 2004 | 2008 |
|---|---|---|---|
| SOE share | 65.12 | 3.61 | 3.33 |
| POE share | 5.64 | 77.59 | 83.06 |
| FOE share | 29.25 | 18.80 | 13.60 |

# Results Driven by Private Firms back

## Table: Average Industry Entry Rate, Industry Real Revenue Growth and Industry HHI

| | Real Revenue Growth | | | log HHI | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| SOE entry | 2.796 | 2.976 | 2.844 | 15.45 | 14.53 | 17.54 |
| | (0.94) | (1.01) | (1.01) | (1.13) | (1.02) | (1.18) |
| POE entry | 0.862*** | 0.466** | 0.417** | -7.091*** | -5.070** | -3.947* |
| | (4.86) | (2.65) | (2.59) | (-3.73) | (-2.64) | (-1.97) |
| FOE entry | 0.123 | 0.341 | 0.377 | -3.957 | -5.071 | -5.883* |
| | (0.45) | (1.40) | (1.63) | (-1.26) | (-1.62) | (-1.87) |
| number of firms | -4.66e-08 | -0.000000875 | -0.00000102 | -0.000124*** | -0.000119*** | -0.000116*** |
| | (-0.07) | (-1.27) | (-1.43) | (-6.28) | (-6.41) | (-6.15) |
| log employment | | -0.0469*** | -0.0246 | | 0.239** | -0.267* |
| | | (-5.82) | (-1.38) | | (2.74) | (-1.90) |
| log revenue | | | -0.0194 | | | 0.441*** |
| | | | (-1.51) | | | (4.09) |
| $R^2$ | 0.196 | 0.245 | 0.251 | 0.521 | 0.531 | 0.552 |
| Observations | 400 | 400 | 400 | 400 | 400 | 400 |

*t* statistics in parentheses

2-digit CIC industry fixed effects controlled; standard errors clustered at 2-digit industry level

$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

# Robustness Check: HHI Growth

back

## Table: Industry HHI Growth and Industry Real Revenue Growth

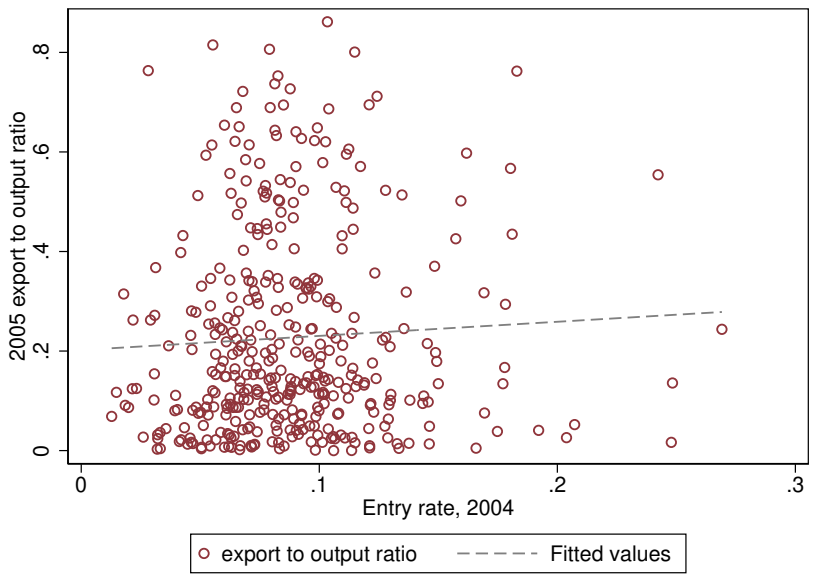
| | Real Revenue Growth | | | HHI Growth | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| average entry rate | 0.830*** | 0.544*** | 0.524*** | -0.479** | -0.434* | -0.458** |
| | (4.98) | (3.53) | (3.61) | (-2.38) | (-1.97) | (-2.09) |
| 2004 industry HHI | -0.144 | -0.111 | -0.0971 | -0.433*** | -0.439*** | -0.422*** |
| | (-0.77) | (-0.55) | (-0.50) | (-2.97) | (-3.08) | (-3.04) |
| 2004 SOE share | 0.249 | 0.285* | 0.265* | 0.303* | 0.297* | 0.274 |
| | (1.60) | (2.01) | (2.00) | (1.83) | (1.78) | (1.61) |
| 2004 number of firms (million) | -0.0458 | -0.912 | -0.975 | 1.280 | 1.417 | 1.341 |
| | (-0.06) | (-1.29) | (-1.36) | (1.37) | (1.67) | (1.56) |
| 2004 log industry employment | | -0.0490*** | -0.0365** | | 0.00777 | 0.0228 |
| | | (-6.82) | (-2.27) | | (0.85) | (1.23) |
| 2004 log industry revenue | | | -0.0105 | | | -0.0126 |
| | | | (-0.88) | | | (-0.90) |
| $R^2$ | 0.204 | 0.262 | 0.264 | 0.124 | 0.125 | 0.127 |
| Observations | 400 | 400 | 400 | 400 | 400 | 400 |

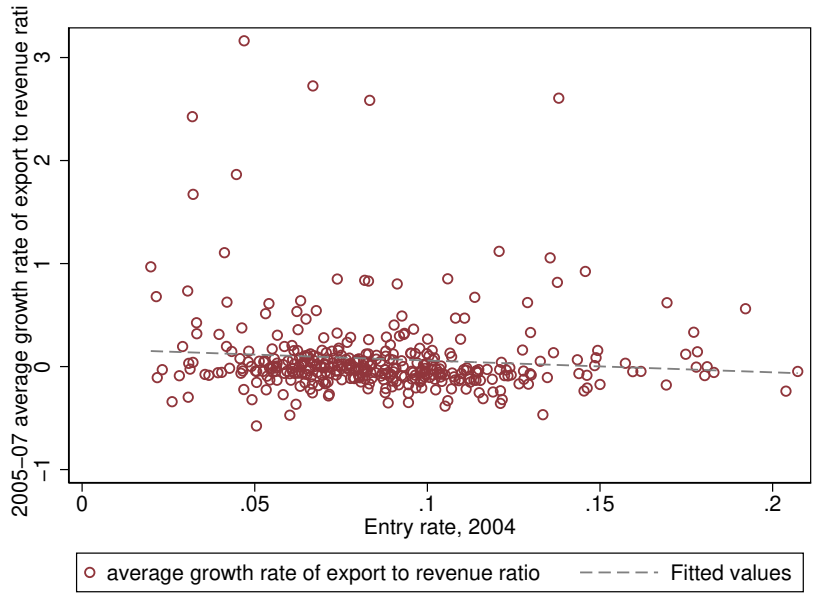
*t* statistics in parentheses

2-digit CIC industry fixed effects controlled; standard errors clustered at 2-digit industry level

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

# Results Not Driven by Exporting Firms



# Results Not Driven by Exporting Firms back

Table: Productivity Growth of Exporting Firms, ASIE

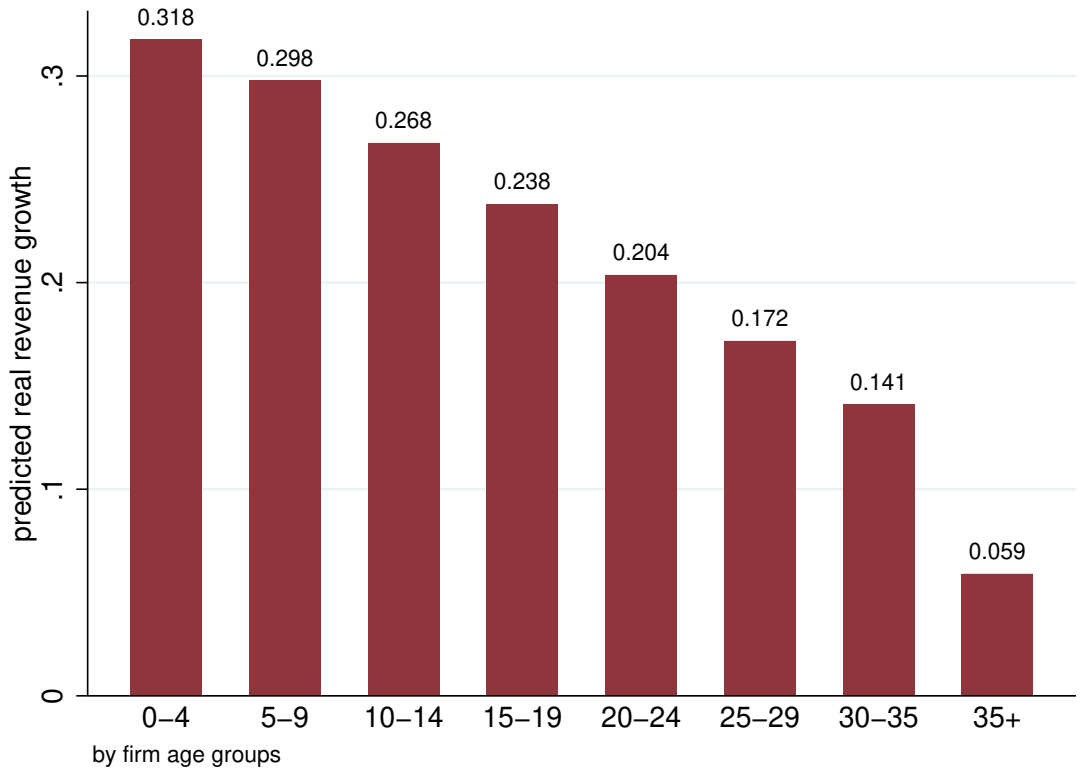
| | Productivity growth | | |
|---|---|---|---|
| | (1) | (2) | (3) |
| Positive share of export | 0.0272*** | | |
| | (11.37) | | |
| Export more than 50% of output | | -0.0180*** | |
| | | (-5.43) | |
| Share of export | | | 0.149*** |
| | | | (11.27) |
| Share of export squared | | | -0.152*** |
| | | | (-10.82) |
| $R^2$ | 0.117 | 0.146 | 0.117 |
| Observations | 566,559 | 140,439 | 566,559 |

$t$ statistics in parentheses

4-digit-industry-year-province fixed effects controlled; standard errors clustered at 4-digit industry level

$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

# Predicted Annual Firm Revenue Growth by Age Group




back to empirical back to model

# Robustness Check: other measures for firm-level output

back

Table: Firm-level Output Growth

| | (1) prodty | (2) va | (3) revenue | (4) output |
|---|---|---|---|---|
| average entry rate | 0.444** | 0.651** | 0.814*** | 0.670*** |
| | (2.09) | (2.70) | (3.28) | (2.85) |
| firm age | -0.00141* | -0.00588*** | -0.00562*** | -0.00606*** |
| | (-2.01) | (-6.67) | (-5.90) | (-6.43) |
| average entry rate × firm age | -0.0251*** | -0.0403*** | -0.0530*** | -0.0429*** |
| | (-3.93) | (-5.22) | (-5.12) | (-5.03) |
| $R^2$ | 0.011 | 0.023 | 0.015 | 0.021 |
| 2-digit industry F.E. | Yes | Yes | Yes | Yes |
| 2-digit industry clustered S.E. | Yes | Yes | Yes | Yes |
| Observations | 314032 | 314032 | 314029 | 314032 |

*t* statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

# Robustness Check: other measures for size interaction

back

## Table: Firm-level Productivity Growth with Interactions

| | (1) | (2) | (3) |
|---|---|---|---|
| average entry rate | 0.444** | 0.381** | 0.271* |
| | (2.09) | (2.34) | (1.72) |
| firm age | -0.00141* | -0.00346*** | -0.00350*** |
| | (-2.01) | (-7.70) | (-7.79) |
| log firm employment | 0.0809*** | 0.0985*** | 0.0824*** |
| | (17.91) | (20.64) | (17.80) |
| log firm real capital | -0.00444 | -0.00386 | 0.00180 |
| | (-1.09) | (-0.94) | (0.45) |
| average entry rate × firm age | -0.0251*** | | |
| | (-3.93) | | |
| average entry rate × firm emp | | -0.00112*** | |
| | | (-7.92) | |
| average entry rate × firm capital | | | -0.00000543*** |
| | | | (-4.95) |
| Constant | -0.0277 | -0.0946*** | -0.0677** |
| | (-0.89) | (-3.30) | (-2.54) |
| $R^2$ | 0.011 | 0.011 | 0.011 |
| 2-digit industry F.E. | Yes | Yes | Yes |
| 2-digit industry clustered S.E. | Yes | Yes | Yes |
| Observations | 314032 | 314032 | 314032 |

*t* statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

# Model: Households

- Each industry consists of two firms and the industry output is

$$y_\nu(t) = \left[ y_{\nu,1}(t)^\delta + y_{\nu,2}(t)^\delta \right]^{1/\delta}.$$

The demand for firm $\iota$'s output

$$y_\iota = \frac{p_\iota^{1/(\delta-1)}}{p_1^{\delta/(\delta-1)} + p_2^{\delta/(\delta-1)}}, \quad \iota = 1, 2$$

The own price elasticity of demand $\epsilon_\iota$ is

$$\epsilon_\iota = \frac{1 - \delta\omega_\iota}{1 - \delta},$$

where $\omega_\iota \equiv p_\iota y_\iota$ is the revenue share of firm $\iota$. Note $\omega_\iota$ is a function of $p_1/p_2$ and so is $\epsilon_\iota$.

# Model: Product Market back

- Each firm sits at the $n_\iota$−th rung on a quality ladder and produces using labor

$$y_\iota = \lambda^{n_\iota} l_\iota$$

The unit cost is $c_\iota = \lambda^{-n_\iota}$.

- The two firms engage in Bertrand competition. The optimal pricing is

$$\max_{p_\iota}(p_\iota - c_\iota)y_\iota \Rightarrow p_\iota = \frac{\epsilon_\iota}{\epsilon_\iota - 1}c_\iota$$

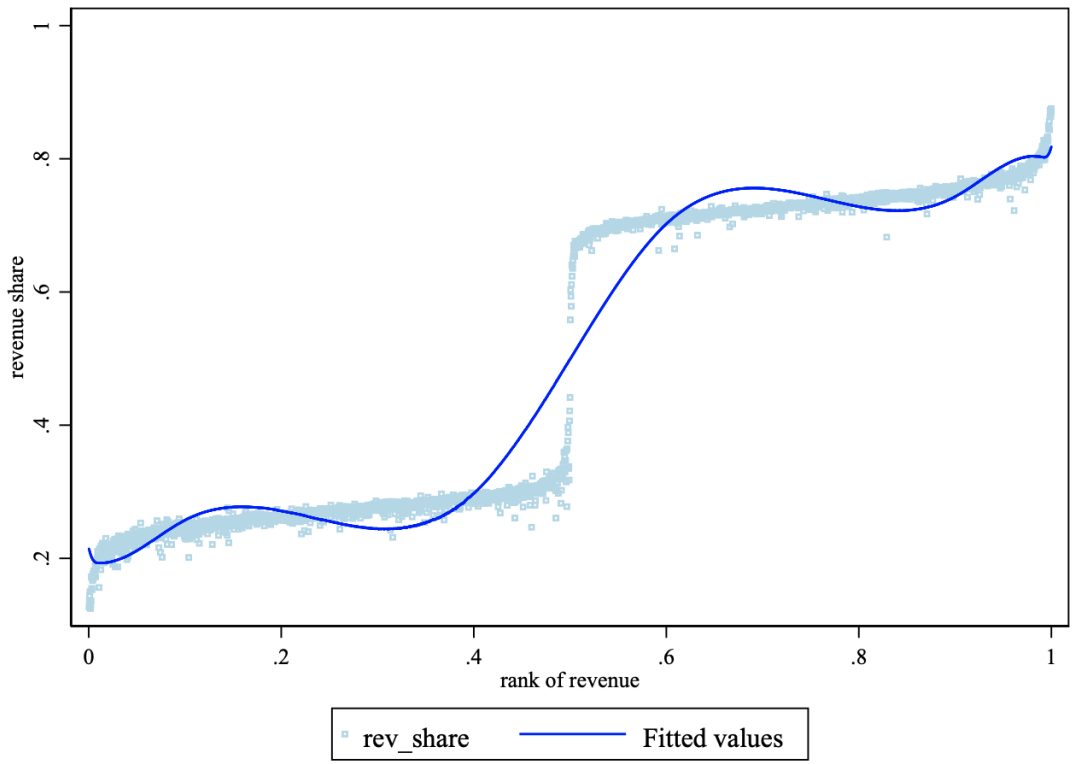
The profit is

$$\pi_\iota = \frac{\omega_\iota}{\epsilon_\iota}$$

Revenues and profits are functions of $\frac{p_1}{p_2}$ and ultimately $\frac{c_1}{c_2} = \lambda^{-(n_1 - n_2)}$.

# Logistic Function of Revenue Shares in the Data

back



# Value Functions in Unleveled Industries

Back

A follower's value:

$$r\overline{V}_{ij}(n) = \max_{\overline{x}_{ij}(n)} \overline{\pi}(n) - \beta_j \frac{\overline{x}_{ij}(n)^{\alpha}}{\alpha} + \overline{x}_{ij}(n)\{\phi[V^j_{ji}(0) - \overline{V}_{ij}(n)] + (1-\phi)[\overline{V}_{ij}(n-1) - \overline{V}_{ij}(n)]$$
$$+ \sigma_i[\overline{V}_{lj}(n) - \overline{V}_{ij}(n)] + \sigma_j[\overline{V}_{il}(n) - \overline{V}_{ij}(n)] + x_{ij}(n)[\overline{V}_{ij}(n+1) - \overline{V}_{ij}(n)]$$
$$+ x^e_{ij}(n)[0 - \overline{V}_{ij}(n)].$$

# Value Functions in Neck-and-Neck Industries

Back

An incumbent's value:

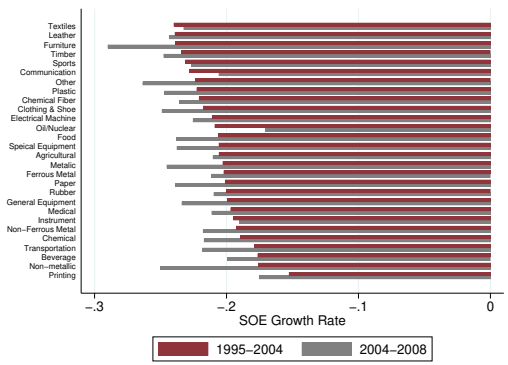
$$rV_{ij}^{i}(0) = \max_{x_{ij}^{i}(0)} \pi(0) - \beta_i \frac{x_{ij}^{i}(0)^{\alpha}}{\alpha} + x_{ij}^{i}(0)[V_{ij}(1) - V_{ij}^{i}(0)] + \sigma_i[V_{lj}^{l}(0) - V_{ij}^{i}(0)]$$
$$+ \sigma_j[V_{i\ell}^{i}(0) - V_{ij}^{i}(0)] + x_{ji}^{j}(0)[\overline{V}_{ji}(1) - V_{ij}^{i}(0)]$$
$$+ x_{ij}^{e}(0)\left\{\frac{1}{2}\left[0 - V_{ij}^{i}(0)\right] + \frac{1}{2}\left[\overline{V}_{hi}(1) - V_{ij}^{i}(0)\right]\right\}.$$

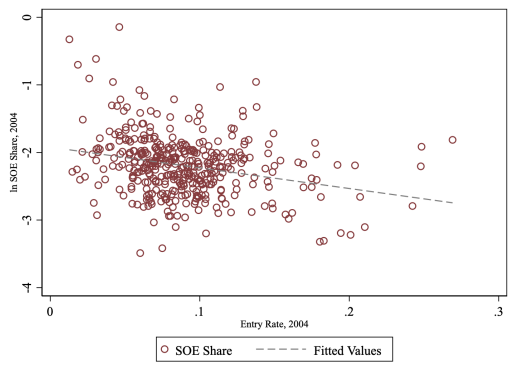
An entrant's value:

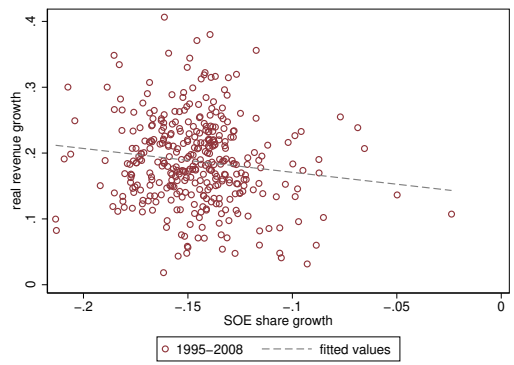
$$V_{ij}^{e}(0) = \max_{x_{ij}^{e}(0)} -\tau_s \beta_h \frac{x_{ij}^{e}(0)^{\alpha}}{\alpha} + x_{ij}^{e}(0)\left[\frac{1}{2}V_{hi}(1) + \frac{1}{2}V_{hj}(1)\right].$$

# Entry Barriers and SOE Reform

- Gradual Reform (Li et al. 2015)
- Negative correlation between SOE share and entry
- Negative correlation between SOE share growth and real revenue growth



# Entry Barriers and SOE Reform

Back

## Table: Industry Real Revenue Growth and SOE Share Growth

| | 1995-2004 | | 1995-2008 | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| SOE share growth (95-04) | -0.709*** | -0.628*** | | |
| | (-4.40) | (-3.55) | | |
| SOE share growth (95-08) | | | -0.545*** | -0.408*** |
| | | | (-4.40) | (-3.06) |
| total number of firms | -0.00000419** | -0.00000576** | -0.00000306** | -0.00000504*** |
| | (-2.09) | (-2.47) | (-2.64) | (-3.42) |
| average employment | | -0.0236*** | | -0.0297*** |
| | | (-4.76) | | (-7.03) |
| Constant | 0.0261 | 0.164*** | 0.111*** | 0.284*** |
| | (0.78) | (3.86) | (6.11) | (9.94) |
| $R^2$ | 0.205 | 0.237 | 0.201 | 0.280 |
| Observations | 358 | 358 | 358 | 358 |

*t* statistics in parentheses

2-digit industry F.E. controlled; standard errors clustered at 2-digit industry level

$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

# Entry Barriers and SOE Reform

Back

Table: Industry SOE Share and Industry Entry Rate

| | (1) | (2) |
|---|---|---|
| soe share | -0.0245*** | -0.0428*** |
| | (-3.57) | (-5.73) |
| log industry revenue | -0.00418** | -0.0293*** |
| | (-2.68) | (-5.57) |
| Constant | 0.131*** | 0.391*** |
| | (7.07) | (5.74) |
| $R^2$ | 0.066 | 0.509 |
| 4-digit industry F.E. | No | Yes |
| Observations | 1174 | 1164 |

*t* statistics in parentheses

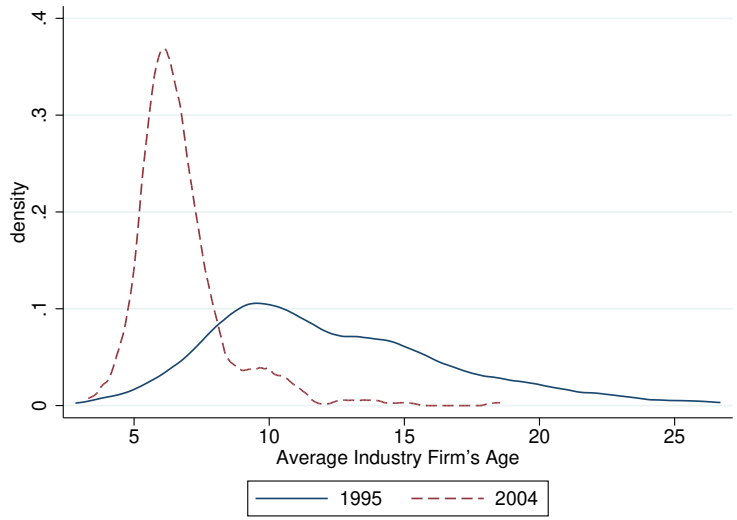
standard errors clustered at 2-digit industry level

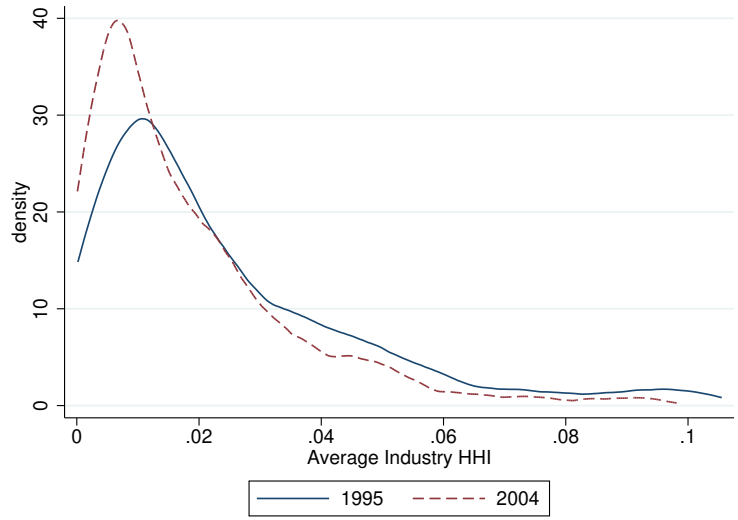
$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

# Entry Barriers and SOE Reform

Back

- Average Age and HHI Distribution, 1995 vs 2004



## Sector Heterogeneity: Replacement Effect back

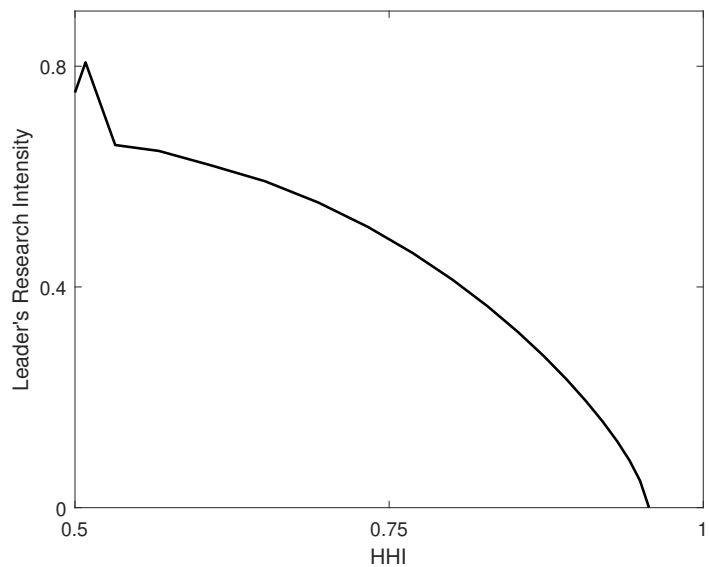
- Distribution of Industry Types

| | (H,H) | (H,L) | (L,H) | (L,L) | H Leader | H Follower |
|---|---|---|---|---|---|---|
| Sector 1 | 0.036 | 0.056 | 0.157 | 0.250 | 18.4% | 38.6% |
| Sector 2 | 0.070 | 0.065 | 0.182 | 0.183 | 27.0% | 50.4% |

# Sector Heterogeneity: Pro-competitive Effect

- Innovation is stronger in more competitive sectors (small $n$ and HHI)

Figure: Leader's Innovation intensity and HHI in (H,H) industry, Sector 2



# Sector Heterogeneity: Pro-competitive Effect

back

Table: Industry HHI and Industry Real Revenue Growth

| | (1) | (2) | (3) |
|---|---|---|---|
| log HHI | -0.00906** | -0.0137** | -0.0181*** |
| | (-2.12) | (-2.47) | (-3.37) |
| number of firms (million) | | -1.687 | -2.202*** |
| | | (-1.32) | (-2.95) |
| $R^2$ | 0.011 | 0.015 | 0.139 |
| 2-digit industry F.E. | No | No | Yes |
| 2-digit industry clustered S.E. | No | No | Yes |
| Observations | 400 | 400 | 400 |

$t$ statistics in parentheses

$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

# Entry Rates by Sectors back

| | 1995 mean | 2004 median | 1994 median | 2004 median |
|---|---|---|---|---|
| Sector 1 | 0.040 | 0.065 | 0.032 | 0.065 |
| Sector 2 | 0.052 | 0.111 | 0.046 | 0.104 |