Where Has All the Dynamism Gone? Productivity Growth in China's Manufacturing Sector: 1998-2013

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Motivation

- We know a lot about China's productivity growth during 1998-2007
- Brandt, Van Biesebroeck and Zhang (2012)
  - uses "Annual Survey of Above-Scale Industrial Enterprises" from the National Bureau of Statistics (NBS)
  - documents high productivity growth in this period
  - main driver is the "creative destruction" forces - firm entry/exit

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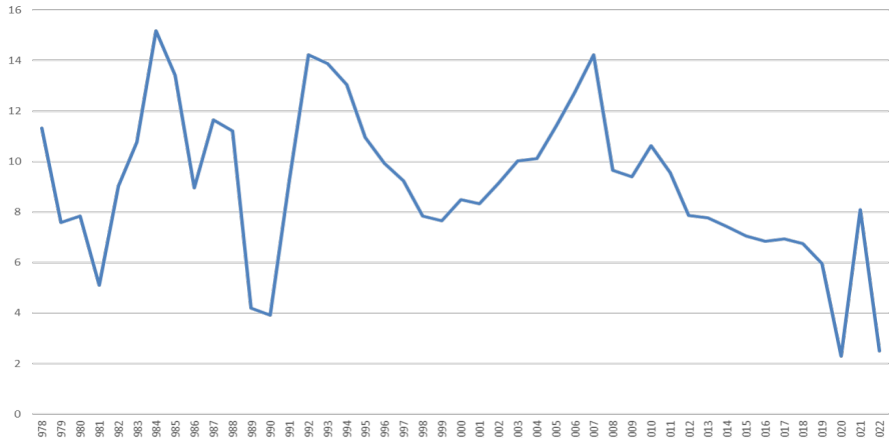
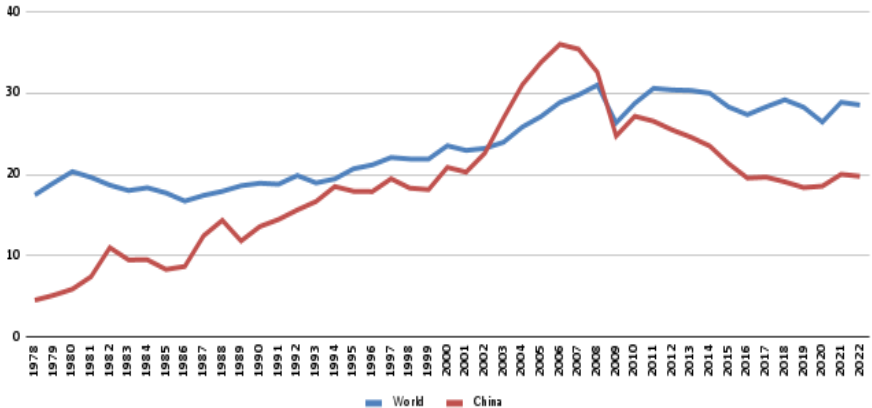
  - documents high productivity growth in this period
  - main driver is the "creative destruction" forces - firm entry/exit
- However, lack of reliable, comparable data has been a bottleneck to studying years after 2007
- 2007-2008: seems to be a turning point in China's economic development
  - GDP growth, export, inequality, etc.

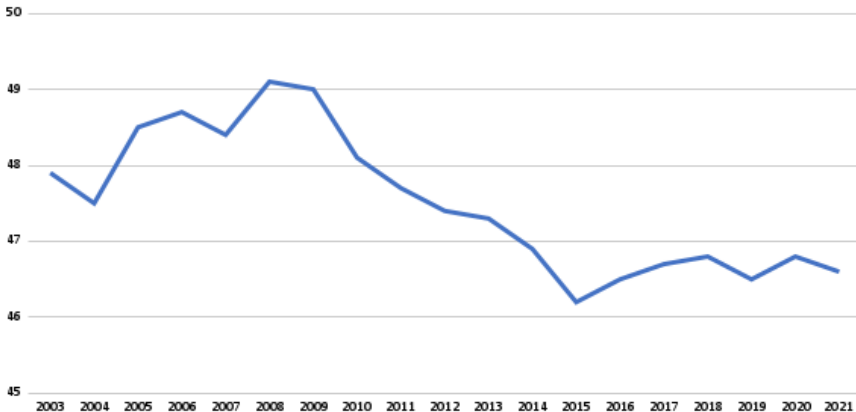
Growth slowed down after 2007



Export/GDP Ratio (%)



Gini coefficient (%)



Our paper

- Combine NBS data with the firm-level data from State Taxation Administration (STA) for 2007-2013
  - leverage the reliability of STA and representativeness of NBS into a micro sample that is comparable to the earlier series
- Develop a weighting method, in the spirit of Hellerstein and Imbens (1999), to simulate samples for estimation and analysis
- Examine the TFP evolution of the manufacturing sector
  - Annual TFP growth drops from 4.4% in 1998-2007 to 1.5% in 2007-2013
  - Uniform decline across almost all sectors, ownership types and regions
  - Substantial decline in the contribution of new entry in both quantity and quality

Outline

1. Data
2. Weighting method
3. Production function estimation
4. TFP growth analysis
5. Conclusions

Annual Survey of Above-Scale Industrial Enterprises by NBS

- Coverage: 1998-2009, 2011-2013, mining, manufacturing, and utilities
- Sampling:
  - all SOEs and firms with annual sales above 5 mio. RMB
  - around 200,000-300,000 firms each year

Problems for 2008-2013:

- Over-reporting of output
- Information missing on key variables
- Abnormal employment numbers in 2011-2013:

Annual Survey by State Taxation Administration (STA)

- Coverage: 2007-2013 industrial and service sector
- Sampling:
  - Group and listed companies
  - Focus firms: mostly firms with tax benefits or special procedures (VAT rebate)

Key challenge: sampling weights

- No information on the designed weight for each strata
- Sampling weights are subject to local adjustment, tax revenue coverage, survey capacity and cost, etc.

Weighting STA observations

- Composition - generate weights for observations in the STA survey that are representative of their weight in the target population (original NBS sample)
  - Time-invariant weighting function: assuming constant STA sampling scheme
  - Variable weighting function: more flexible but requires additional assumptions
- Sample size - determine the number of firms to sample by size category
- Draw simulated sample from STA survey

Weighting STA observations

- Assume production function

$$y = s(\mathbf{x}; \theta) + \omega^* + \varepsilon \quad \text{with} \quad E(\varepsilon) = 0$$

  - Output: y
  - Unobserved persistent productivity: ω^* (latent, of interest)
  - Input variables: $\mathbf{x} = (k, l, m)$ (may depend on ω^*)
  - Other variables: $\mathbf{z}$ (may affect input variables or ω but do not enter PF directly) eg. location, age, ownership, paid-in capital, exporting status, export value, fixed assets at original value, etc.
- Indicator of being sampled in the STA survey: $S = 1, 0$
- Density functions of the target sample (NBS) in year t: $f_t^T(.)$
- Density functions of the source sample (STA) in year t: $f_t^S(.)$

Density ratio as weighting function

Estimates of interest are some moments in the target sample

In our case, the industry level productivity as joint moments of y and ω^*

$$\begin{aligned} m_t^T(y, \omega^*) &= m_t^T(y, y - s(\mathbf{x}; \theta)) \\ &= \int_y \int_{\mathbf{x}} g(y, \mathbf{x}) f_t^T(y, \mathbf{x}) d_{\mathbf{x}} d_y \\ &= \int_y \int_{\mathbf{x}} g(y, \mathbf{x}) f_t^S(y, \mathbf{x}) \frac{f_t^T(y, \mathbf{x})}{f_t^S(y, \mathbf{x})} d_{\mathbf{x}} d_y \end{aligned}$$

Define

$$r_t(y, \mathbf{x}) = \frac{f_t^T(y, \mathbf{x})}{f_t^S(y, \mathbf{x})}$$

Specification and estimation of weighting function

Estimate two variants

- Let $r_t(y, \mathbf{x}) = r_{2007}(y, \mathbf{x})$ for $t > 2007$
  - Assume time invariant sampling scheme in STA survey
  - May fail to capture sampling scheme adjustment
- Estimate year-specific $\widetilde{r}_t(k, \mathbf{z}) = \frac{f_t^T(k,\mathbf{z})}{f_t^S(k,\mathbf{z})}$ instead
  - True if $(k, \mathbf{z})$ predict the same sampling weight as $(y, \mathbf{x})$

$$P_t(S = 1|y, \mathbf{x}) = P_t(S = 1|k, \mathbf{z})$$

  - $\mathbf{z}$ include paid-in capital, firm age, export status, export value, ownership type, province of location, fixed asset at original value, total wage bill
- Denote by $\mathbf{v}$ either $(y, \mathbf{x})$ or $(k, \mathbf{z})$
- Estimation by Least Square Importance Fitting (Kanamori et al. 2009)

Production function estimation

Gross-output production function (for each 2-digit CIC sector)

$$y_{it} = f(k_{it}, l_{it}, m_{it}) + \omega_{it} + \varepsilon_{it}, \quad \text{with} \quad \omega_{it} = \rho\omega_{it-1} + \eta_{it}$$

Estimation with GNR (Ghandhi et al. 2020):

- Using info. on material share to determine output elasticity of materials
- Non-parametric production function: average firm-specific output elasticities
- Unlike the index number methods, estimate returns to scale freely

Separate estimation for 2 periods: 1998-2007 (NBS) vs. 2007-2013 (simulated)

TFP and growth estimates

- Firm-year level TFP estimates - output purged of contribution of inputs

$$\widehat{\omega}_{it}^{t} + \widehat{\varepsilon}_{it} = y_{it} - \widehat{f}(k_{it}, l_{it}, m_{it})$$

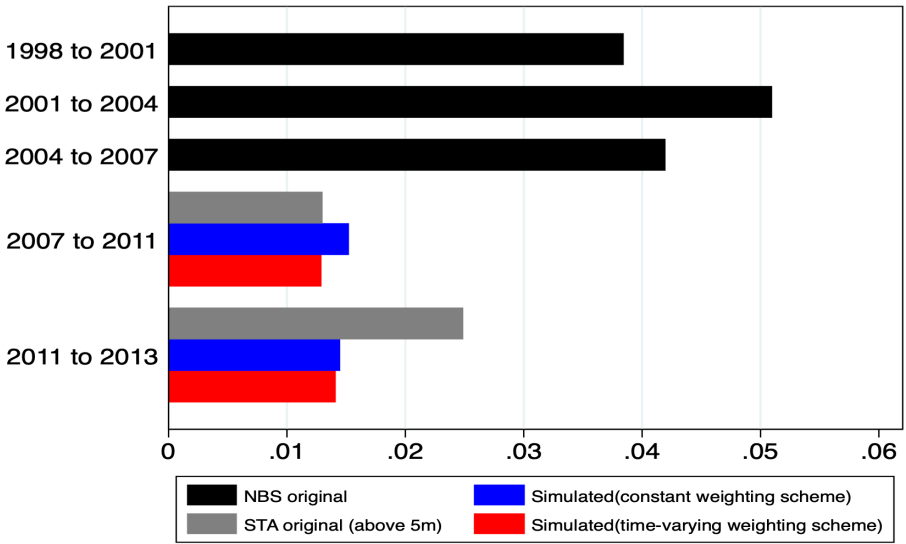
- Industry level (j) growth from t_0 to t_1

$$TFPG_{t_0 t_1}^{j} = \sum_{i \in \mathcal{F}_{t_1}^{j}} share_{it_1} * \widehat{\omega}_{it_1} - \sum_{i \in \mathcal{F}_{t_0}^{j}} share_{it_0} * \widehat{\omega}_{it_0}$$

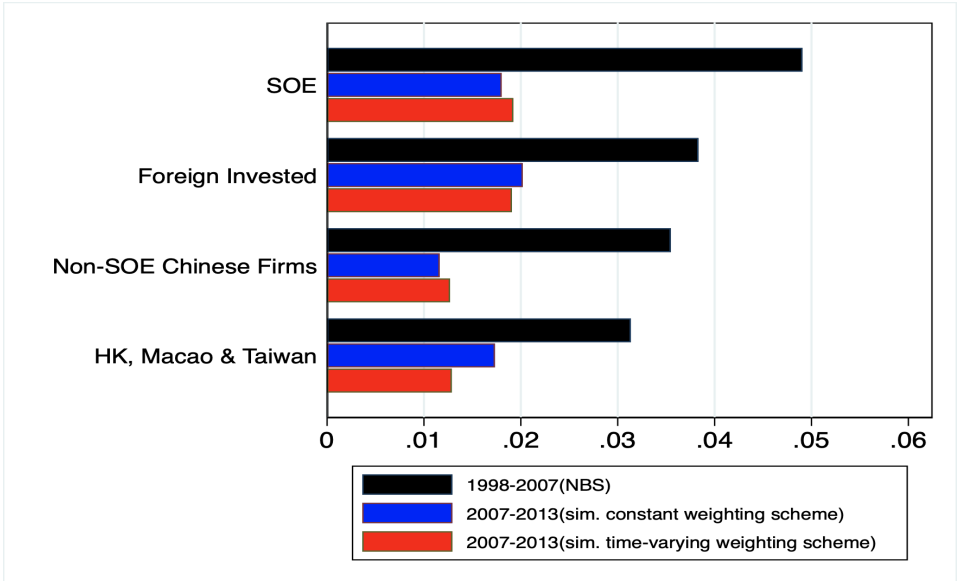
- Manufacturing sector level growth from t_0 to t_1

$$TPFG_{t_0 t_1}^{mfg} = \sum_{j} share^{j} * TFPG_{t_0 t_1}^{j}$$

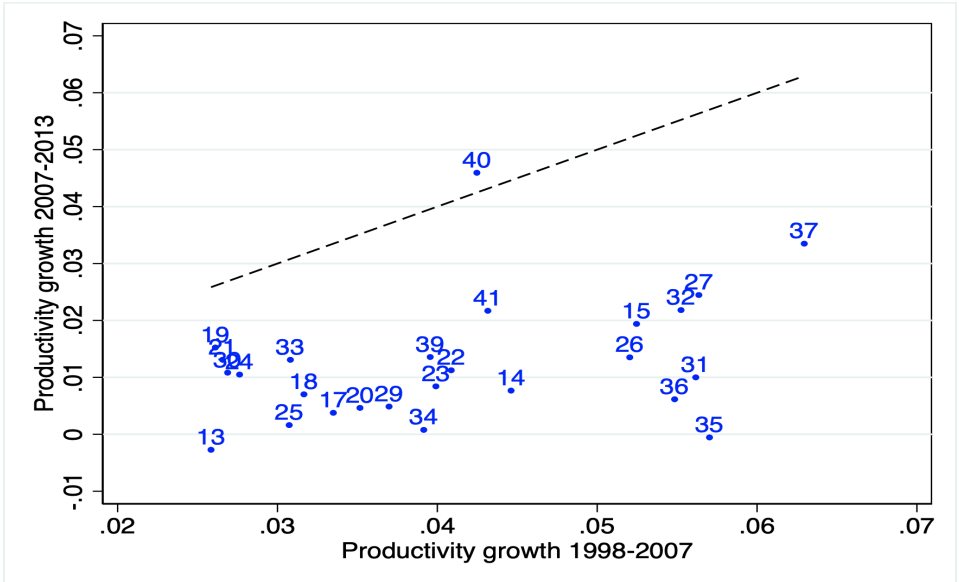
Annualized Aggregate productivity growth



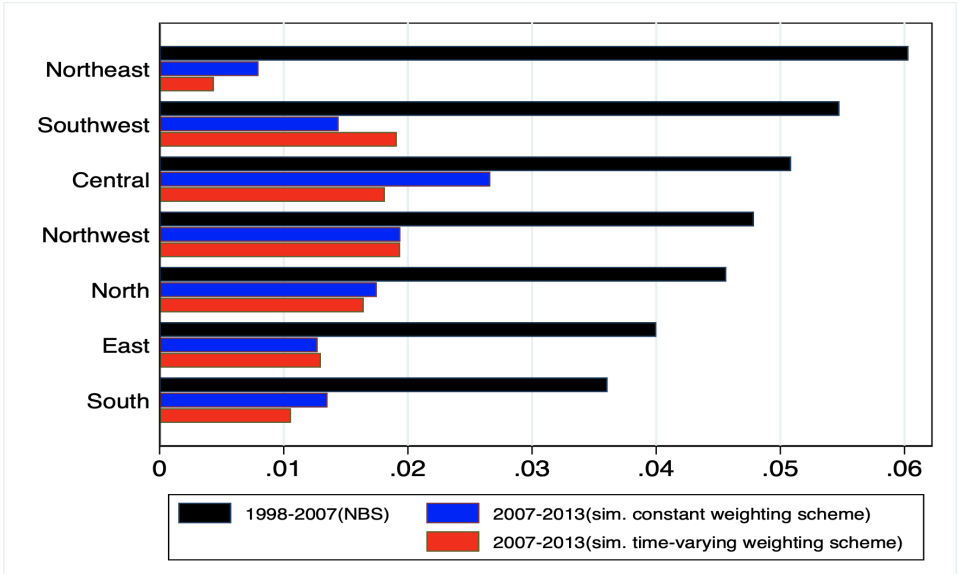
Productivity growth by ownership type



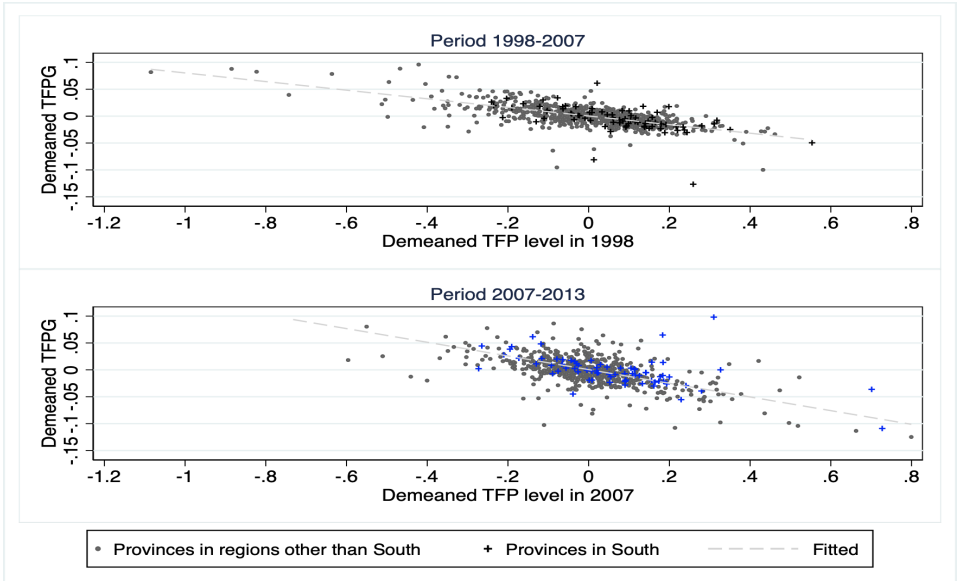
Productivity growth by industry



Productivity growth by region



Persistent productivity convergence across provinces



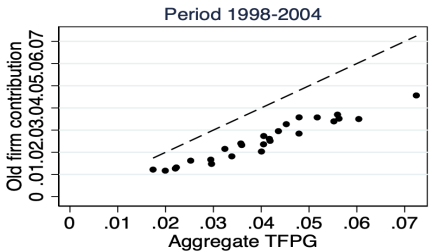
Firm dynamics and TFP growth decomposition

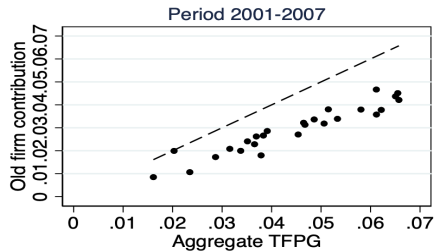
- Our decomposition for the change in aggregate TFP from year o to year t is

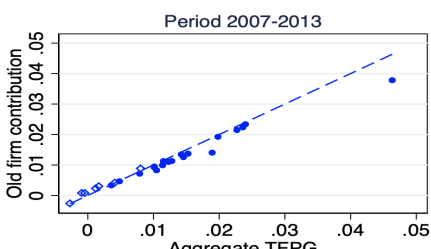
$$\overline{\omega}_t - \overline{\omega}_o = \sum_{i \in C} s_{it} \left(\omega_{it} - \overline{\omega}_o \right) + \sum_{e \in EN} s_{et} \left(\omega_{et} - \overline{\omega}_o \right)$$

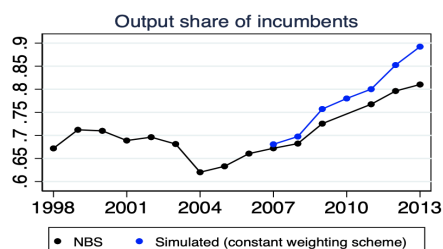
  - The first term measures the contribution of continuing firms and firm exit
  - The second term measures the contribution of entrants

Old firms' contribution to aggregate productivity growth





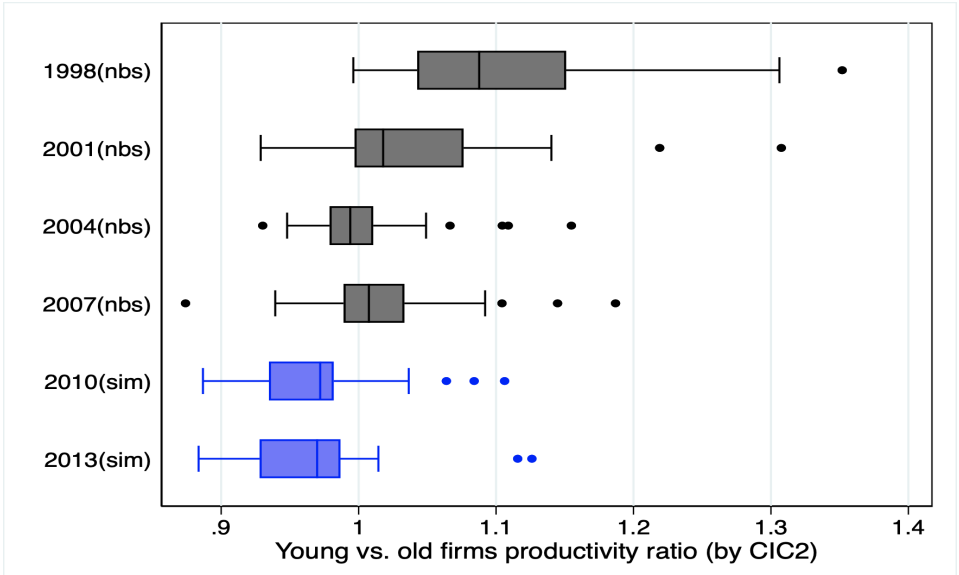




Falling entry rates (NBS, above 20 m.)

			Entrant ownership composition			
Year	Total	Entrant share	SOE	NonSOE	HMT	FOR
1998	48,815	7%	17%	53%	14%	16%
2001	59,261	8%	11%	67%	12%	10%
2004	107,327	12%	4%	69%	12%	14%
2007	183,341	8%	3%	76%	9%	11%
2008	215,976	8%	3%	81%	7%	8%
2009	224,041	6%	3%	87%	5%	5%
2010						
2011	275,365	6%	3%	91%	3%	3%
2012	283,841	5%	3%	90%	4%	4%
2013	315,762	5%	2%	92%	4%	3%

Falling relative productivity of young firms



Conclusions

- Document a less utilized micro sample that supplements the NBS survey
- Introduce a method to leverage the advantage of different micro-level datasets
- Examine the pattern of TFP growth in China's manufacturing section over 2007-2013, with two major findings
  - Substantial and uniform decline
  - Loss of dynamism - the decreasing role of new firms
- Additional explanations for the sharp decline in productivity growth
  - Internal factors
  - External factors