The State and China's Productivity Deceleration: Firm-level Evidence

Jorge Alvarez, Tuo Chen, Grace Li

International Monetary Fund

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Motivation

- The Chinese SOE reform and privatization process slowed-down after the crisis
- The total factor productivity (TFP) of the manufacturing sector decelerated around the same time
- Empirical evidence shows that the privatization process accounted for a significant share of growth during the early 2000s (Hsieh and Song 2014 WP)
- A natural question: Can the TFP deceleration be explained by the reversal of the privatization/reform process?

Chinese privatization process and its reversal

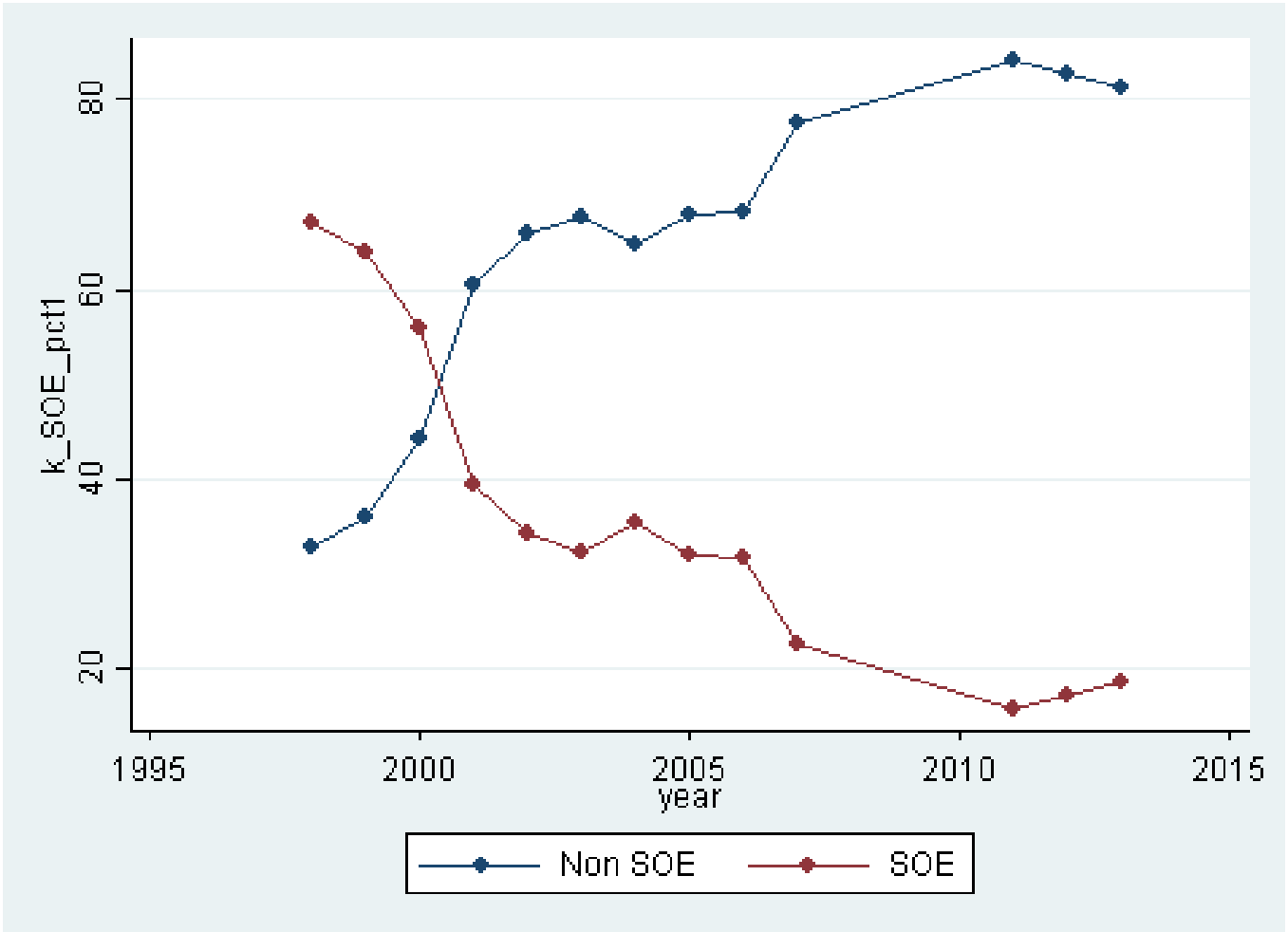


Figure 1: Shares of Capital by SOE category

TFP growth in China

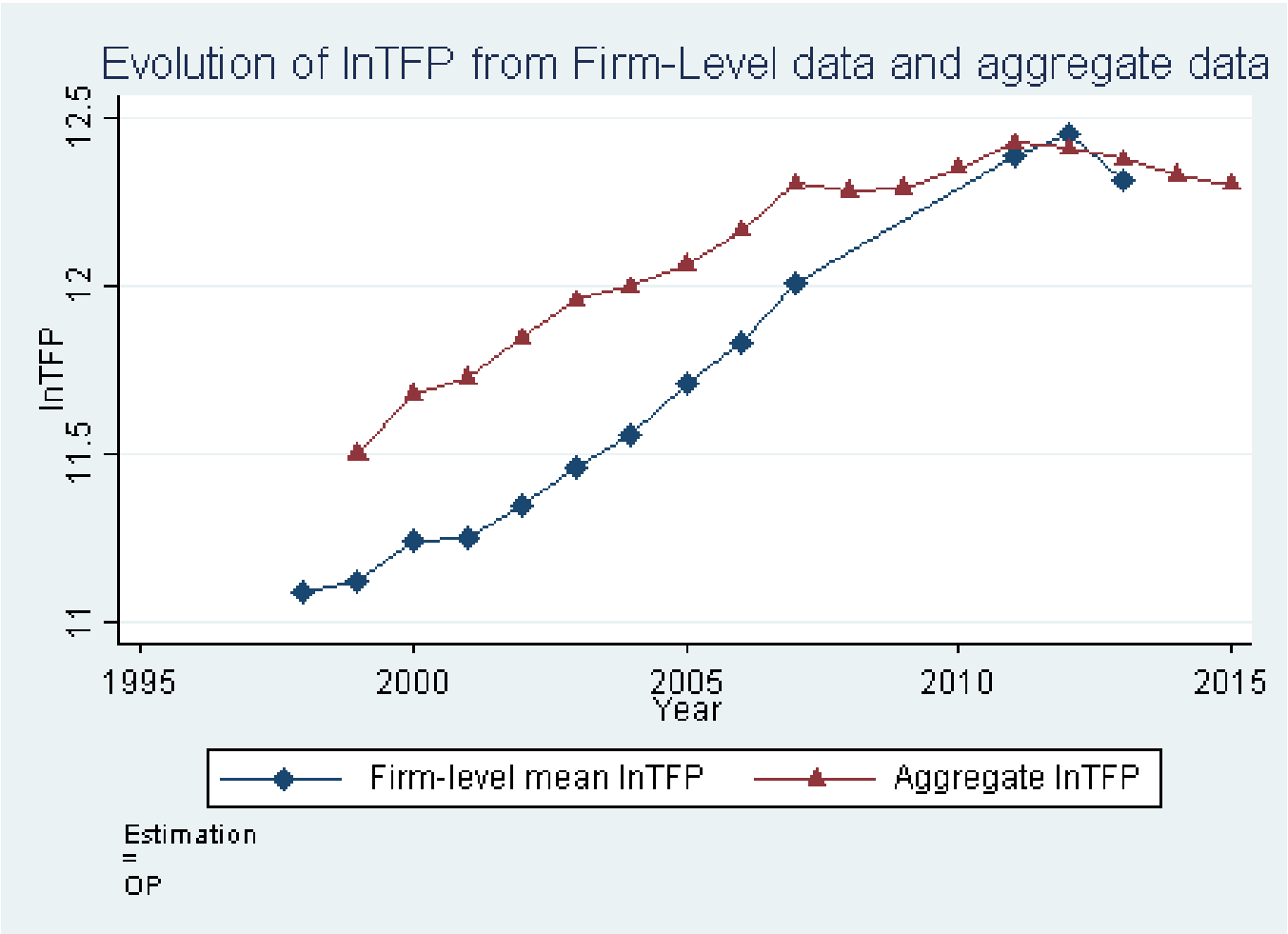


Figure 2: Firm-level Estimation and Aggregate Estimation

This paper

- Documents TFP dynamics (growth and deceleration) in Chinese manufacturing at both the aggregate and firm level
- Estimates TFP gaps between SOEs and private firms
- Assesses the role of SOEs in explaining aggregate TFP dynamics

Preview of the results

- The TFP growth trend in the manufacturing sector reversed in 2011
- Within-firm TFP changes among SOEs were a major contributor to this reversal
- Improvements in resource allocation during the growth period across SOE firms seem to have stopped

Aggregate TFP

Data

- Aggregate Data: China Industry Statistical Yearbook
  - Coverage: 1998 - 2015
  - Contains value added, intermediate inputs, and labor
- Firm-level Data: Chinese Industrial Survey (1998 - 2013)
  - Coverage: 1998 - 2013
  - Value added (1998-2007), sales income, sales cost, and fixed assets
    - Pseudo value added: sales income - sales cost

TFP measurement

- Aggregate level TFP estimation:
  - Cobb-Douglas, constant returns to scale
- Firm level TFP estimation:
  - Cobb-Douglas
  - Olley-Pakes (1996): $a_{ist} = \omega(k_{ist}, inv_{ist}, ...)$
  - Levinsohn-Petrin (2003): $a_{ist} = \omega(k_{ist}, m_{ist}, ...)$
  - De-Locker (2011): correct for the potential price bias
- All TFP measures give the same trend and have a high correlation

Firm-level estimation: Olley-Pakes (1996)

- First Step: $y_{ist} = \alpha + \beta^l l_{ist} + \phi(k_{ist}, inv_{ist}) + \varepsilon_{ist}$
  where $\phi(k_{ist}, inv_{ist}) = \beta^k k_{ist} + \omega(k_{ist}, inv_{ist})$
- $\widehat{\phi}_{ist} = y_{ist} - \hat{\beta}_l l_{ist} - \hat{\alpha}$
- Second Step: Assume a_{ist} follows an Markov process:
  $a_{ist+1} = g(a_{ist}) + \eta_{ist}$
- $\widehat{\phi}_{ist+1} = \beta_0 + \beta^k k_{ist+1} + g(\omega(k_{ist}, inv_{ist})) + \nu_{ist}$
- Use higher order polynomials to approximate the unknown function $g(.)$ and $\omega(.,.)$
- y_{ist} is the log value of real value added, l_{ist} is the log value of labor, k_{ist} is the log value of real fixed asset
- Levinsohn-Petrin 2003 replaces inv_{ist} by m_{ist}

Firm-level estimation: De Loecker (2011)

- Monopolistic competition
- First Step: $y_{ist} = \alpha + \beta^{l*} l_{ist} + \beta^{s} y_{st} + \phi(k_{ist}, m_{ist}) + \varepsilon_{ist}$
  where $\phi(k_{ist}, m_{ist}) = \beta^{k*} k_{ist} + \omega(k_{ist}, m_{ist})$
  elasticity of substitution: $\varepsilon_s = \frac{1}{\beta^s}$
  $\beta^l = \beta^{l*} \frac{1}{1+\widehat{\beta^s}}$
  $\beta^k = \beta^{k*} \frac{1}{1+\widehat{\beta^s}}$
- $\widehat{\phi}_{ist} = y_{ist} - \hat{\beta}_{l*} l_{ist} - \hat{\beta}^{s} y_{st} - \hat{\alpha}$
- Second Step: Assume a_{ist} follows an Markov process: $a_{ist+1} = g(a_{ist}) + \eta_{ist}$
- $\widehat{\phi}_{ist+1} = \beta_0 + \beta^{k*} k_{ist+1} + g(\omega(k_{ist}, m_{ist})) + \nu_{ist}$
- Use higher order polynomials to approximate the unknown function $g(.)$ and $\omega(.,.)$
- y_{ist} is the log value of real value added, l_{ist} is the log value of labor, k_{ist} is the log value of real fixed asset

Correlation of Different Measures

Table 1: DlnTFP Correlation measured by VA

Variables	DL	LP	OP	CD
DL	1.000			
LP	0.998	1.000		
OP	0.995	0.997	1.000	
CD	0.942	0.945	0.966	1.000

DL: De Loecker; LP:Levinsohn-Petrin; OP: Olley-Pakes; CD: Cobb-Douglas

Complications in firm-level data

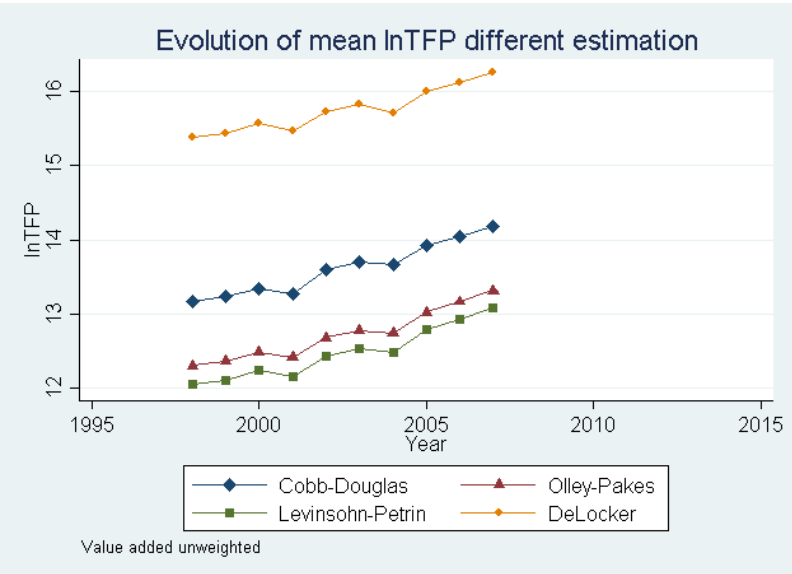
- Value-added data is only available from 1998 to 2007.
- Pseudo-VA = Sales Income - Sales Cost
  - 0.87 correlation with VA
  - available 1998 - 2007, 2011 - 2013

Table 2: DlnTFP Correlation measured by Pseudo VA

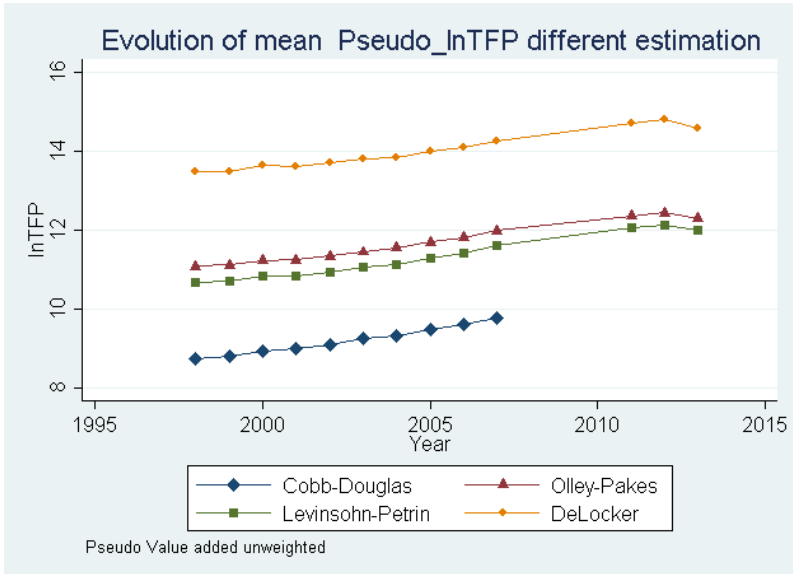
Variables	DL	LP	OP	CD
DL	1.000			
LP	0.997	1.000		
OP	0.991	0.997	1.000	
CD	0.969	0.977	0.982	1.000

DL: De Loecker; LP:Levinsohn-Petrin; OP: Olley-Pakes; CD: Cobb-Douglas

Evolution of average TFP 1



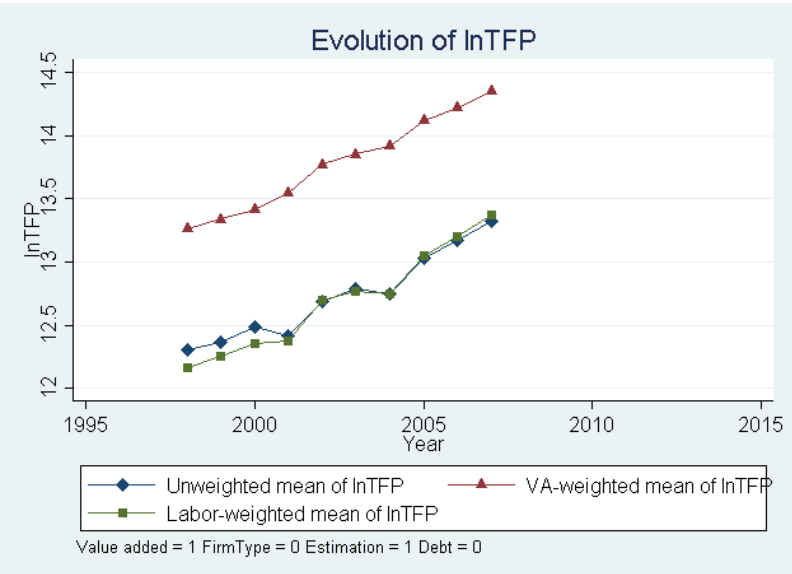
(a) Directly Observed VA



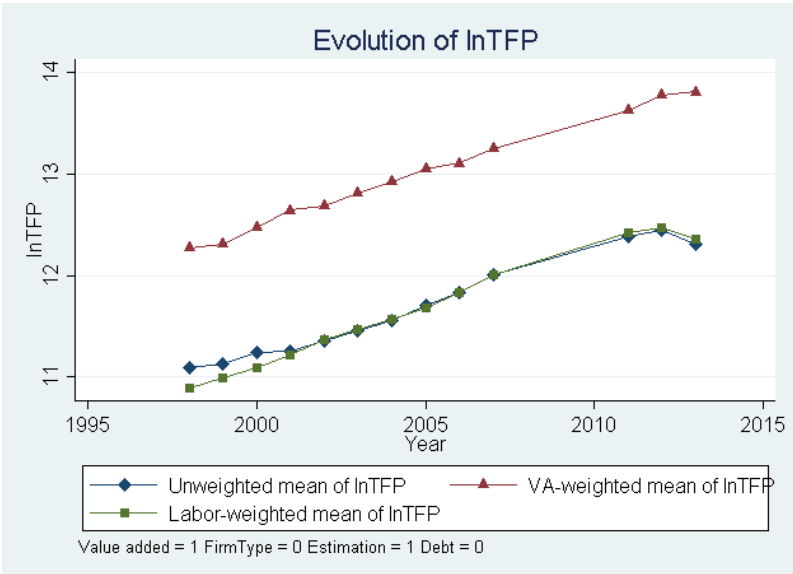
(b) Pseudo VA = Sales Income - Sales Cost

Figure 3: Unweighted Mean of lnTFP by different measures

Evolution of average TFP 2



(a) Directly Observed VA



(b) Pseudo VA = Sales Income - Sales Cost

Figure 4: Mean of lnTFP by different weights

Evolution of average TFP 3

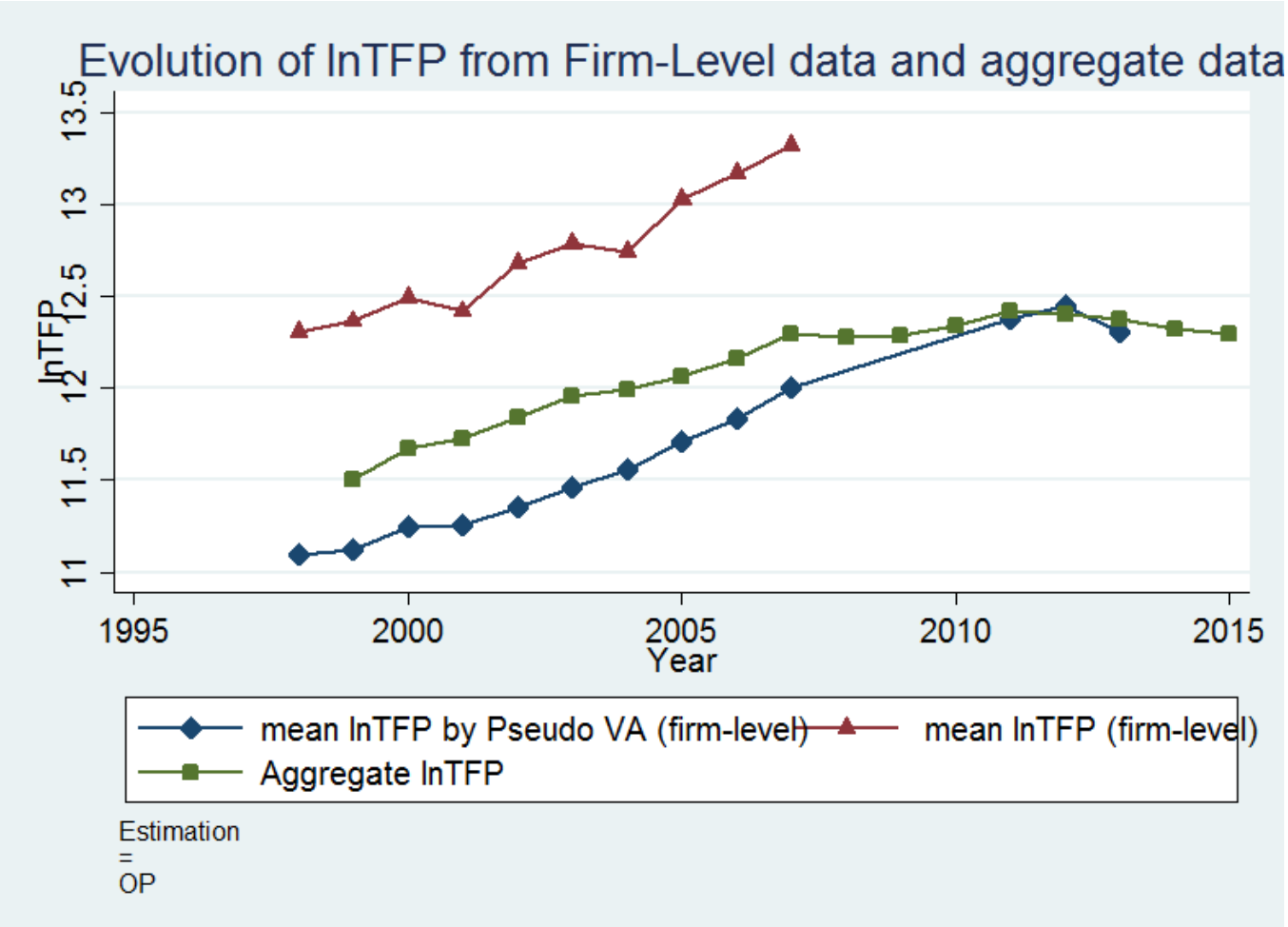


Figure 5: Firm-level Estimation and Aggregate Estimation

Not driven by sectoral composition

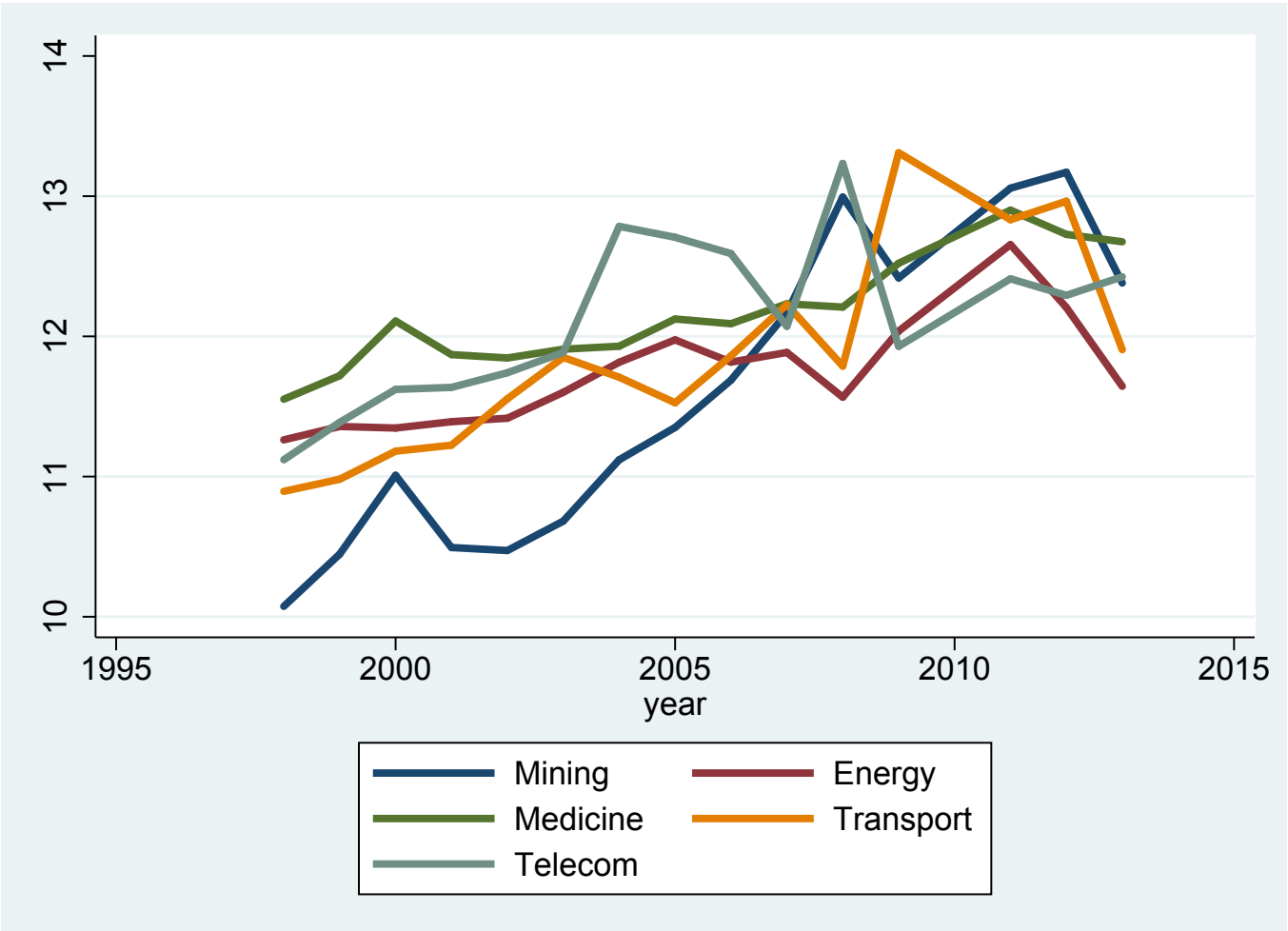


Figure 6: Decomposition by Sectors

SOEs vs Private Firms

SOEs vs private firms: private firms are more productive

Table 3: Sector Premiums

	log(TFP)			
SOE	-0.8780***	-0.8597***	-0.1376***	-0.1259***
	[-108.771]	[-99.022]	[-7.855]	[-7.172]
Fixed Effects				
Year	Yes		Yes	
Sector x Year		Yes		Yes
Firm			Yes	Yes
Number of obs	242,332	242,332	242,332	242,332
R^2	0.153	0.191	0.713	0.716

SOEs vs private firms (cont.): controlling for size

Table 4: Sector Premiums

	log(TFP)			
SOE	-0.6955***	-0.6845***	-0.1295***	-0.1274***
	[-91.724]	[-84.109]	[-8.213]	[-8.057]
Size	0.3147***	0.3166***	0.5668***	0.5688***
	[191.262]	[191.892]	[208.215]	[206.868]
Fixed Effects				
Year	Yes		Yes	
Sector x Year		Yes		Yes
Firm			Yes	Yes
Number of obs	242,119	242,119	242,119	242,119
R^2	0.264	0.297	0.767	0.769

SOEs vs private firms (cont.)

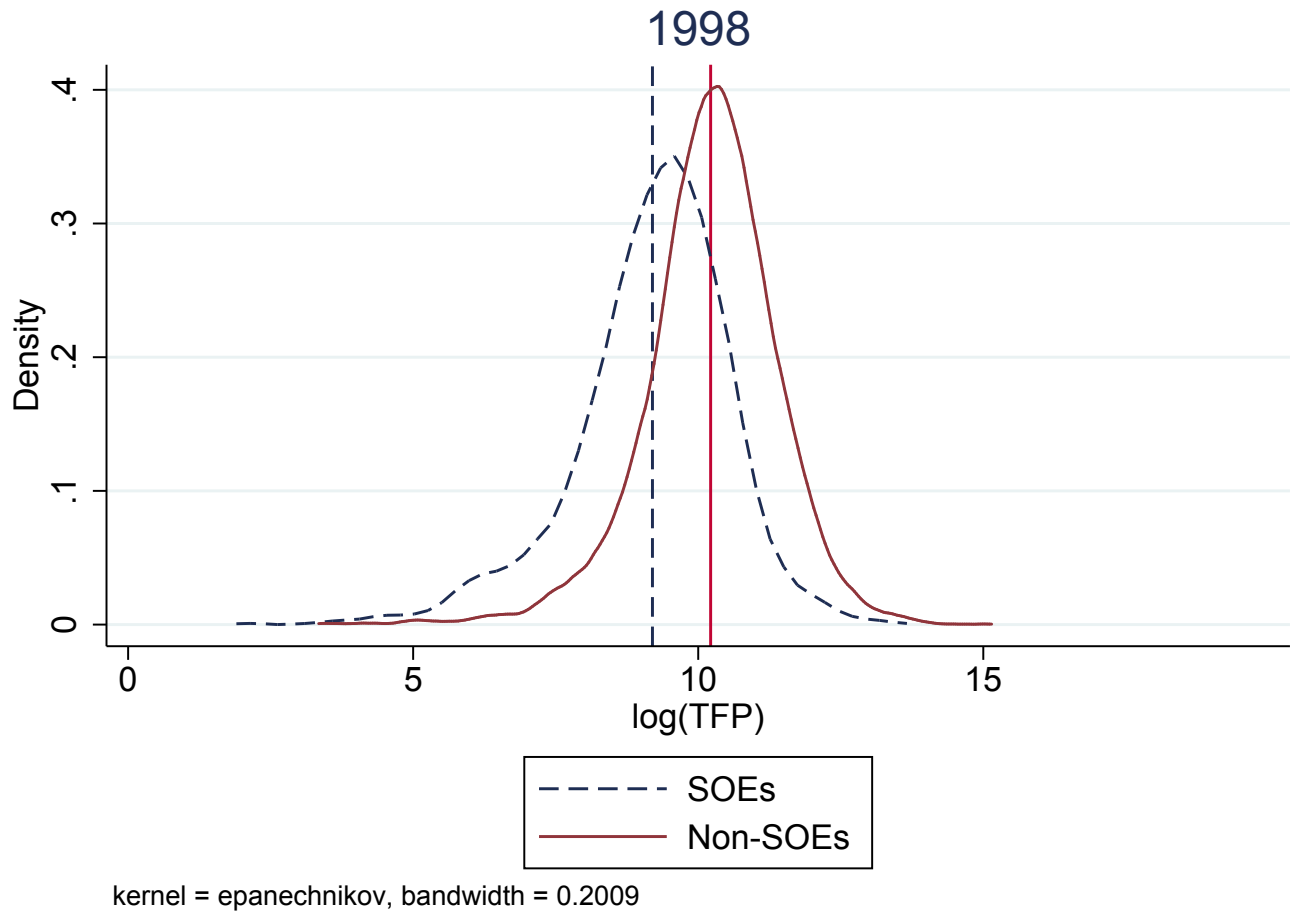


Figure 7: Firm-level TFP for SOEs and private firms

SOEs vs private firms (cont.)

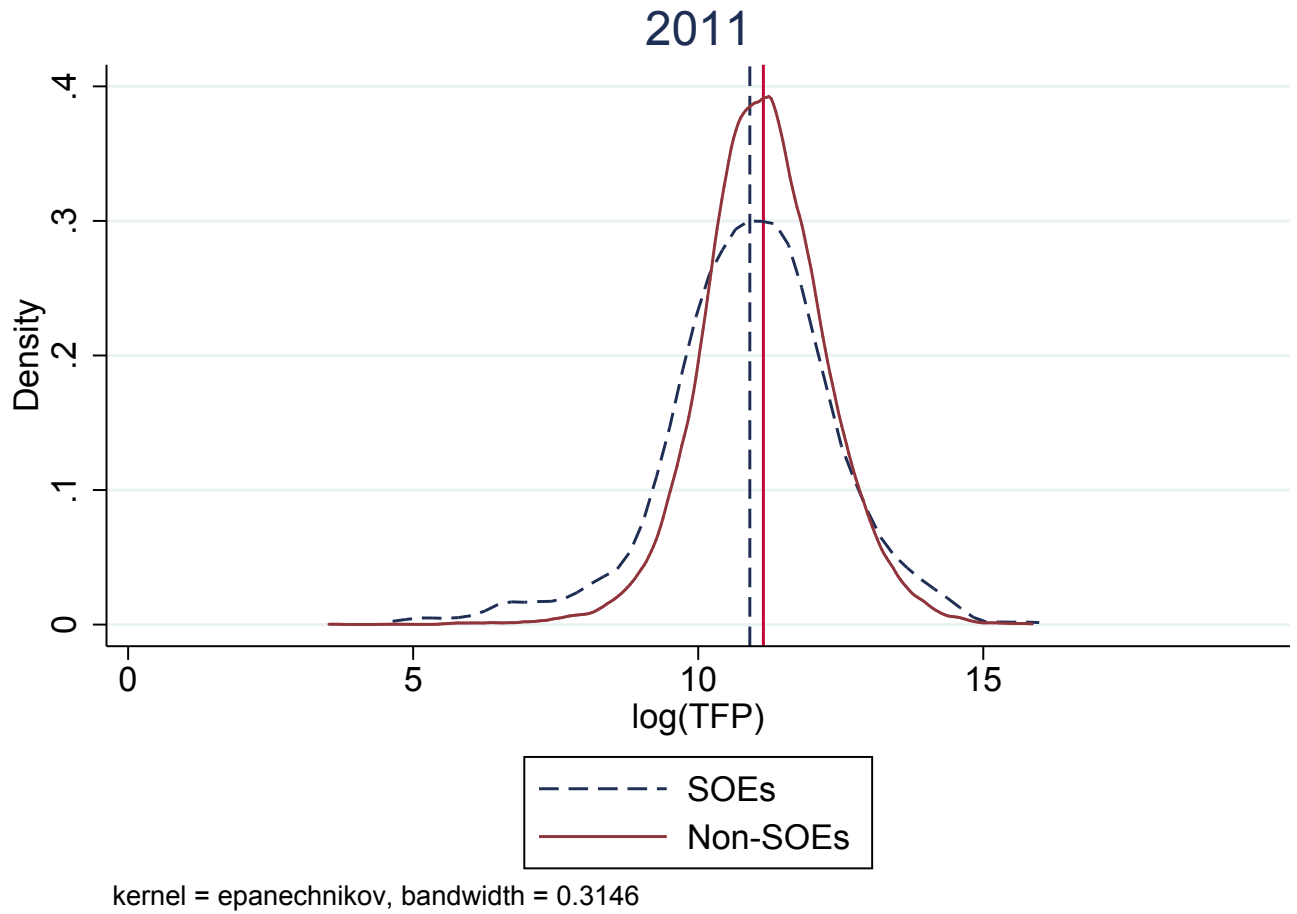


Figure 8: Firm-level TFP for SOEs and private firms

SOEs vs private firms (cont.)

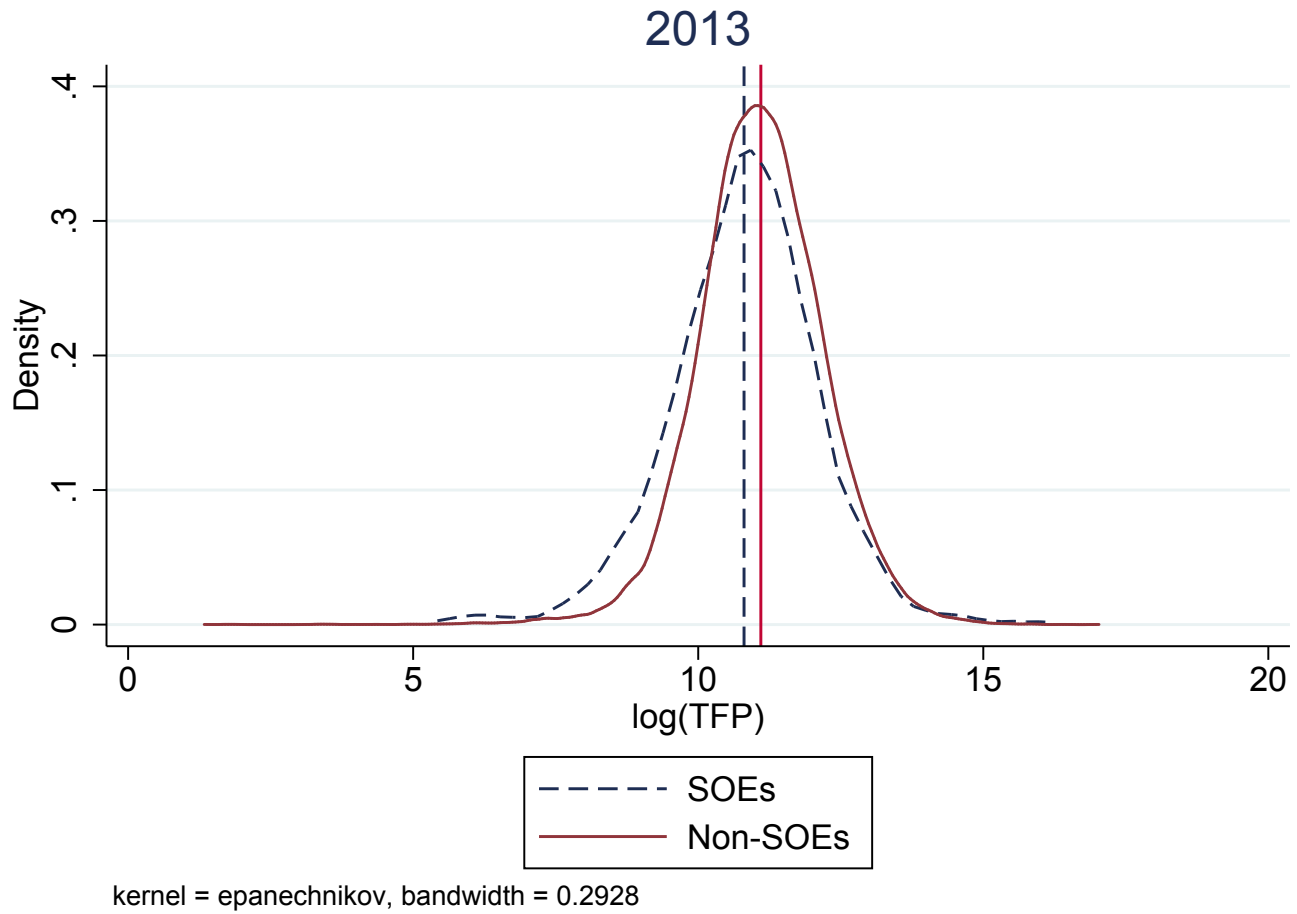


Figure 9: Firm-level TFP for SOEs and private firms

Evolution of SOE premiums

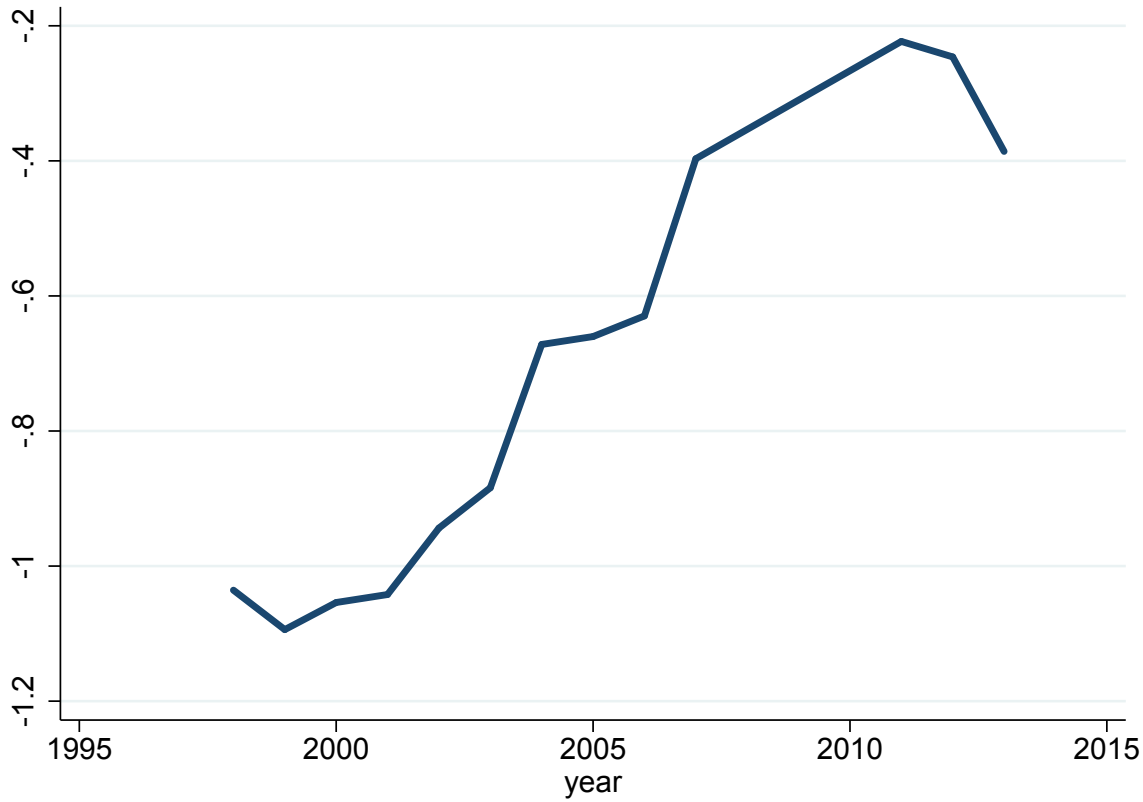


Figure 10: SOE Premiums

Evolution of SOE premiums

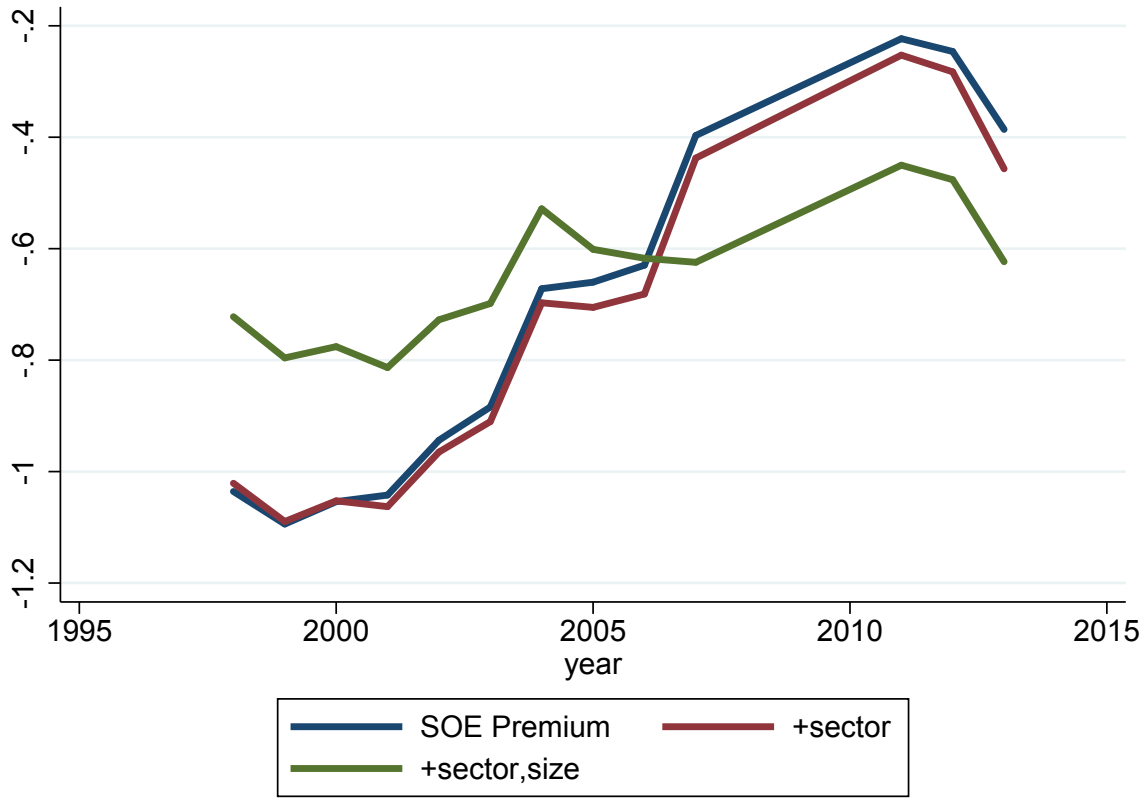


Figure 11: SOE Premiums

Decomposition

The role of SOEs in aggregate TFP

- What is the contribution of SOEs to TFP Dynamics?
- Three channels:
  - Privatization: Movement of labor and capital away from SOEs
  - Reallocation: Movement labor and capital across SOE firms
  - Within-firm dynamics: TFP changes within SOE firms

TFP Decomposition

$$\text{TFP}_t \equiv A_t = \frac{Y_t}{K^\alpha L^\beta} = \Sigma_i A_{it} \frac{k_{it}^\alpha l_{it}^\beta}{K_t^\alpha L_t^\beta}$$

$$= \Sigma_s \frac{\Sigma_{i \in s} k_{it}^\alpha l_{it}^\beta}{K_t^\alpha L_t^\beta} \underbrace{\Sigma_{i \in s} \frac{k_{it}^\alpha l_{it}^\beta}{\Sigma_{i \in s} k_{it}^\alpha l_{it}^\beta} A_{it}}_{\equiv TFP_t^s}$$

$$= \Sigma_s \frac{\Sigma_{i \in s} k_{it}^\alpha l_{it}^\beta}{K_t^\alpha L_t^\beta} TFP_t^s$$

Decomposition of ΔTFP by SOE/Non-SOE Category

$$\Delta TFP_t^*$$

$$\equiv \underbrace{\Sigma_s \frac{\Sigma_{i\in s} k_{ir}^{\alpha} l_{ir}^{\beta}}{K_r^{\alpha} L_r^{\beta}} \Sigma_{i\in s} \frac{k_{ir}^{\alpha} l_{ir}^{\beta}}{\Sigma_{i\in s} k_{ir}^{\alpha} l_{ir}^{\beta}} A_{ir}}_{\text{TFP}_r} - \underbrace{\Sigma_s \frac{\Sigma_{i\in s} k_{it}^{\alpha} l_{it}^{\beta}}{K_t^{\alpha} L_t^{\beta}} \Sigma_{i\in s} \frac{k_{it}^{\alpha} l_{it}^{\beta}}{\Sigma_{i\in s} k_{it}^{\alpha} l_{it}^{\beta}} A_{it}}_{\text{TFP}_t}$$

$$= \underbrace{\Sigma_s \frac{\Sigma_{i\in s} k_{ir}^{\alpha} l_{ir}^{\beta}}{K_r^{\alpha} L_r^{\beta}} [TFP_r^S - TFP_t^S]}_{\text{Within SOE/non-SOE changes}} + \underbrace{\Sigma_s [\frac{\Sigma_{i\in s} k_{ir}^{\alpha} l_{ir}^{\beta}}{K_r^{\alpha} L_r^{\beta}} - \frac{\Sigma_{i\in s} k_{it}^{\alpha} l_{it}^{\beta}}{K_t^{\alpha} L_t^{\beta}}] TFP_r^S}_{\text{Between SOE/non-SOE changes}}$$

$$\underbrace{-\Sigma_s (TFP_r^S - TFP_t^S)(\frac{\Sigma_{i\in s} k_{ir}^{\alpha} l_{ir}^{\beta}}{K_r^{\alpha} L_r^{\beta}} - \frac{\Sigma_{i\in s} k_{it}^{\alpha} l_{it}^{\beta}}{K_t^{\alpha} L_t^{\beta}})}_{\text{Covariance term}}$$

SOE vs Non-SOE Decomposition

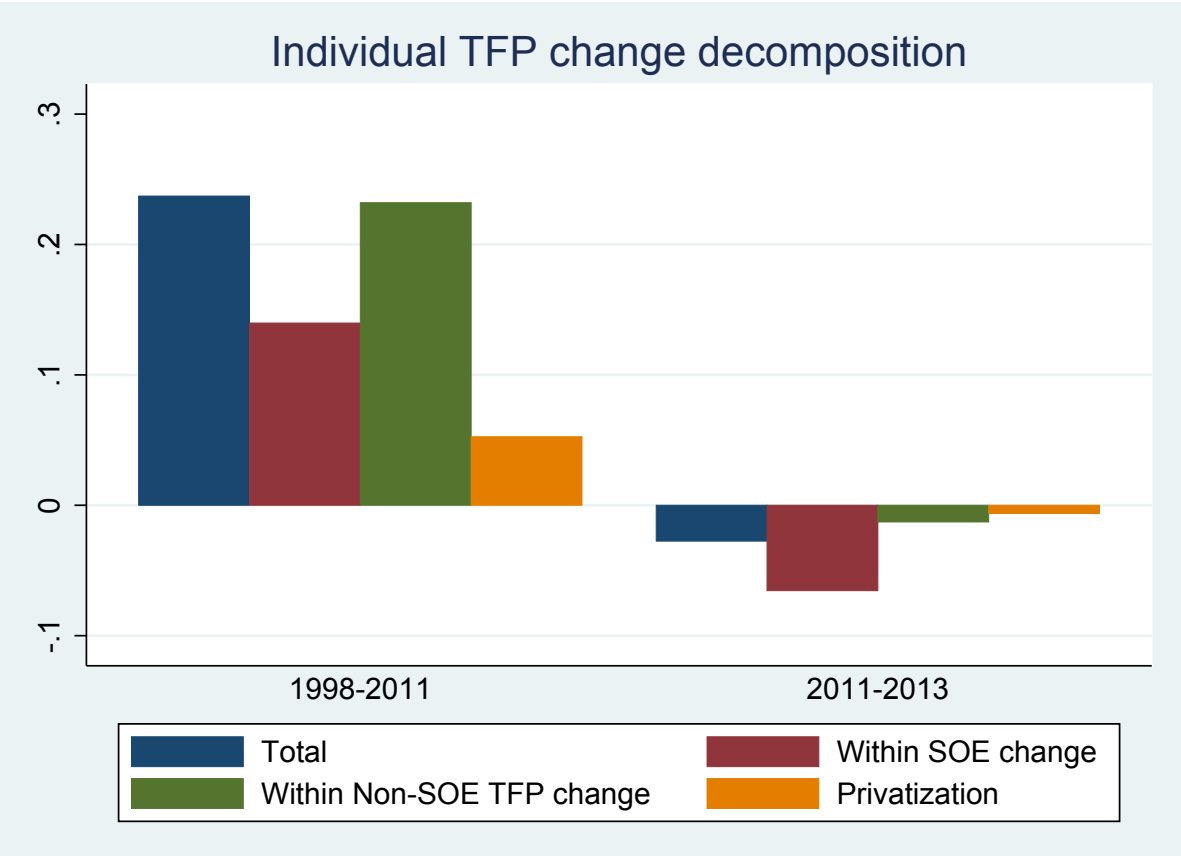


Figure 12: TFP Changes by SOE Category

Between-Within firm decomposition

$$\Delta TFP_t^S \equiv TFP_r^s - TFP_t^s$$

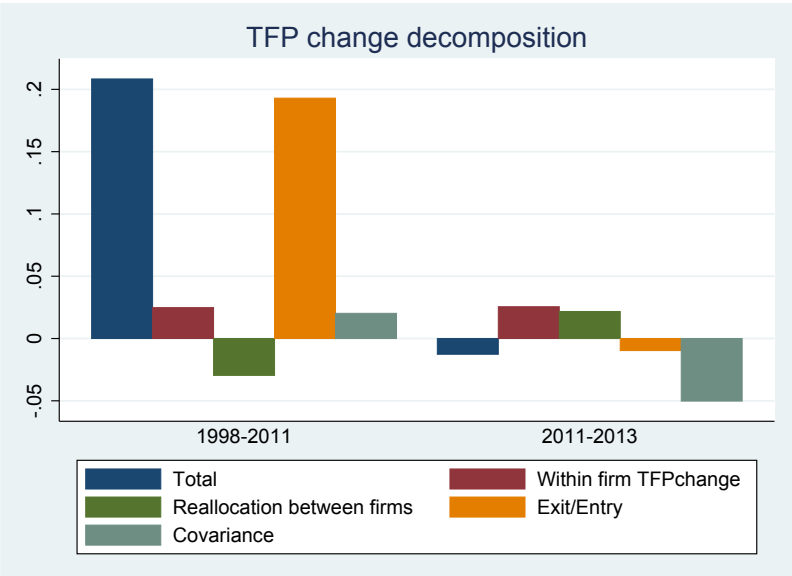
$$= \underbrace{W_{stay^s,r} \Sigma_{i \in stay^s} \frac{k_{ir}^{\alpha} l_{ir}^{\beta}}{\Sigma_{i \in stay^s} k_{ir}^{\alpha} l_{ir}^{\beta}} [A_{ir} - A_{it}]}_{\text{Within Firm}}$$

$$+ \underbrace{W_{stay^s,r} \Sigma_{i \in stay^s} [\frac{k_{ir}^{\alpha} l_{ir}^{\beta}}{\Sigma_{i \in stay^s} k_{ir}^{\alpha} l_{ir}^{\beta}} - \frac{W_{stay^s,t}}{W_{stay^s,r}} \frac{k_{it}^{\alpha} l_{it}^{\beta}}{\Sigma_{i \in stay^s} k_{it}^{\alpha} l_{it}^{\beta}}] A_{it}}_{\text{Between Firm}}$$

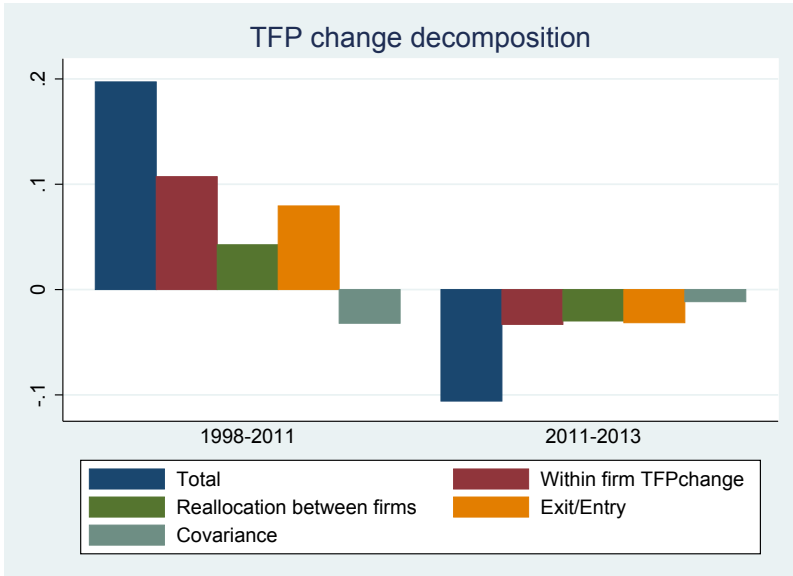
$$+ \underbrace{W_{enter^s,r} \Sigma_{i \in enter^s} \frac{k_{ir}^{\alpha} l_{ir}^{\beta}}{\Sigma_{i \in enter^s} k_{ir}^{\alpha} l_{ir}^{\beta}} A_{ir}}_{\text{Entry}} - \underbrace{W_{exit^s,t} \Sigma_{i \in exit^s} \frac{k_{it}^{\alpha} l_{it}^{\beta}}{\Sigma_{i \in exit^s} k_{it}^{\alpha} l_{it}^{\beta}} A_{it}}_{\text{Exit}}$$

$$\underbrace{- \Sigma_{i \in stay^s} (A_{ir} - A_{it}) (\frac{k_{ir}^{\alpha} l_{ir}^{\beta}}{\Sigma_{i \in s} k_{ir}^{\alpha} l_{ir}^{\beta}} - \frac{k_{it}^{\alpha} l_{it}^{\beta}}{\Sigma_{i \in s} k_{it}^{\alpha} l_{it}^{\beta}})}_{\text{Covariance}}$$

Between-within firm decomposition by SOE category



(a) Within non-SOE TFP Changes



(b) Within SOE TFP Changes

Figure 13: TFP Changes within SOE/Non-SOE

Firm-level decompositions: National SOEs and Local SOEs

Table 5: Zoom into SOEs

Component	1998–2011		1998–2011	
	Δ	%	Δ	%
Within National SOEs	0.20	100.0%	-0.11	100.0%
- Within firm changes	0.11	54.4%	-0.03	31.2%
- Between firm changes	0.04	21.6%	-0.03	28.2%
- Exit / Entry	0.08	40.3%	-0.03	29.7%
- Covariance term	-0.03	-16.2%	-0.01	10.9%
Within Local SOEs	0.11	100.0%	-0.09	100.0%
- Within firm changes	0.02	22.0%	0.00	-3.8%
- Between firm changes	0.02	17.0%	0.02	-17.5%
- Exit / Entry	0.06	54.0%	-0.02	28.9%
- Covariance term	0.01	7.0%	-0.08	92.4%

Conclusion

- There has been a marked deceleration in both aggregate and firm-level measures of manufacturing TFP in China
- Within-firm TFP changes among SOEs and privatization were drivers of aggregate growth from 1998 to 2007
  - This trend reversed after 2011 (or earlier)
- One narrative: after the financial crisis, SOE reforms slowed down
  - "4 Trillion Yuan" stimulus was directed to sub-optimal SOE investments

Next steps

- Explore credit and interest expense data to study the channels through which capital was reallocated across SOE firms
- Study the link between TFP deceleration and contemporaneous state financing programs such as the "4 Trillion Yuan" stimulus package
- Study firms that transitioned out of SOE status using the panel dimension of the data
- Look into expanding data coverage

Cost of debt for SOEs

Figure 14: Mean interest rate (interest expense / debt)

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Misallocation in SOEs?

Figure 15: Variance of marginal product of capital

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Appendix

Firm Decomposition: SOEs vs private firms

Table 6: Sector Premiums - Unweighted

Component	1998–2011		1998–2011	
	Δ	%	Δ	%
Within SOEs	0.20	100.0%	-0.11	100.0%
- Within firm changes	0.11	54.4%	-0.03	31.2%
- Between firm changes	0.04	21.6%	-0.03	28.2%
- Exit / Entry	0.08	40.3%	-0.03	29.7%
- Covariance term	-0.03	-16.2%	-0.01	10.9%
Within Private Firms	0.21	100.0%	-0.01	100.0%
- Within firm changes	0.02	11.9%	0.03	-201.7%
- Between firm changes	-0.03	-14.2%	0.02	-171.5%
- Exit / Entry	0.19	92.6%	-0.01	76.5%
- Covariance term	0.02	9.7%	-0.05	396.7%

SOEs vs private firms (cont.): weighted

Table 7: Sector Premiums - Weighted

	log(TFP)			
	Weighted			
SOE	-0.1428***	-0.4461***	0.0705***	-0.0588***
	[-24.355]	[-67.394]	[7.518]	[-6.187]
Fixed Effects				
Year	Yes		Yes	
Sector x Year		Yes		Yes
Firm			Yes	Yes
Number of obs	242,332	242,332	242,332	242,332
R^2	0.140	0.342	0.851	0.866

SOEs vs private firms (cont.): controlling for size and weighted

Table 8: Sector Premiums - Weighted

	log(TFP)			
	Weighted			
SOE	-0.6475***	-0.7020***	0.0536***	-0.0387***
	[-112.459]	[-112.648]	[6.095]	[-4.311]
Size	0.2355***	0.2292***	0.4274***	0.4191***
	[228.966]	[204.152]	[159.048]	[152.091]
Fixed Effects				
Year	Yes		Yes	
Sector x Year		Yes		Yes
Firm			Yes	Yes
Number of obs	242,119	242,119	242,119	242,119
R^2	0.293	0.440	0.869	0.880

Evolution of SOE premiums

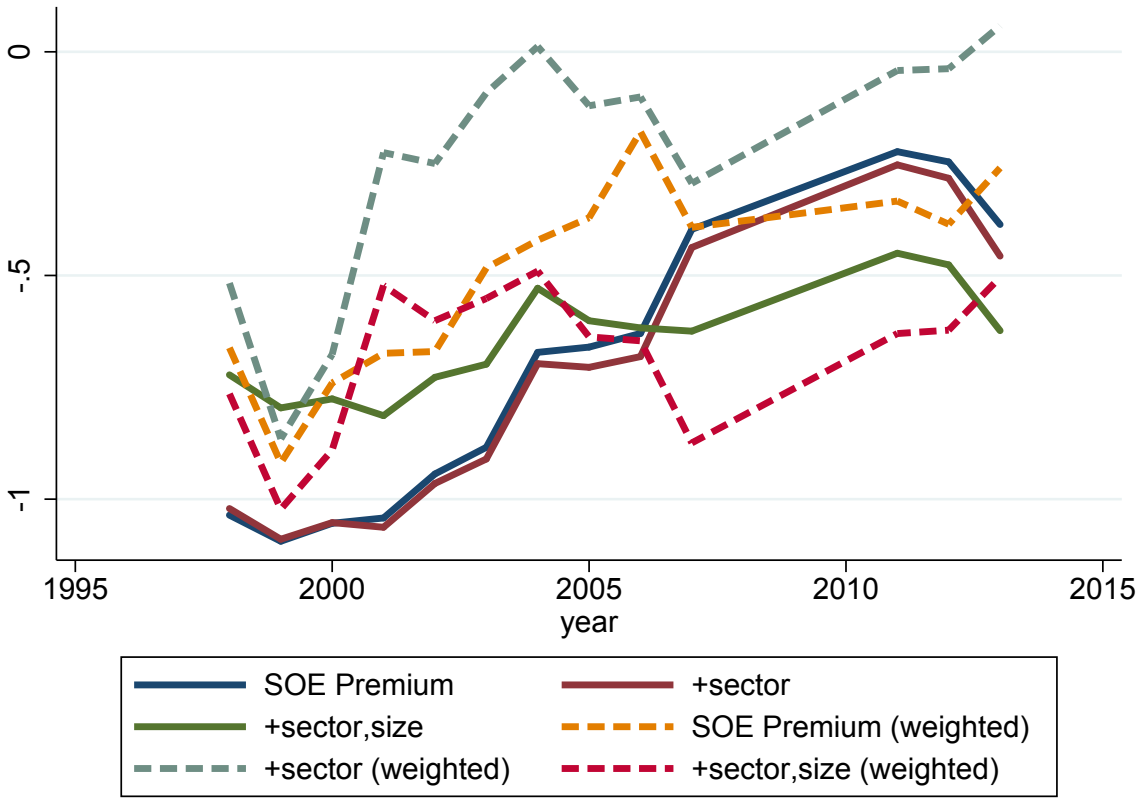

Figure 16: SOE Premiums