Job Creation in African Manufacturing: Lessons from China's Hinterland?

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WORK IN PROGRESS

The 4th GEP Conference in China
'China's External Economic Relations'

Nottingham University Ningbo Campus
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1. Introduction and Motivation
2. Data
3. Some Descriptives
4. Empirical Results
   - Technology Differences
   - Technical (In-)Efficiency
   - Allocative Inefficiency
5. Preliminary Conclusions and Future Work

African Manufacturing and Development

- Renewed interest in **structural composition of LDCs** in the process of development (Lin, 2011; McMillan & Rodrik, 2011; Page, 2011).
- **Decade+ of firm-level surveys** for countries in Sub-Saharan Africa (Bigsten & Söderbom, 2006).
- Waged employment as **best strategy** for poverty reduction (Sandefur & Teal, 2006; Teal, 2008).
- Particular interest in **firm size distribution and dynamics** (Harding, Söderbom, & Teal, 2004; Frazer, 2005; Van Biesebroeck, 2005)

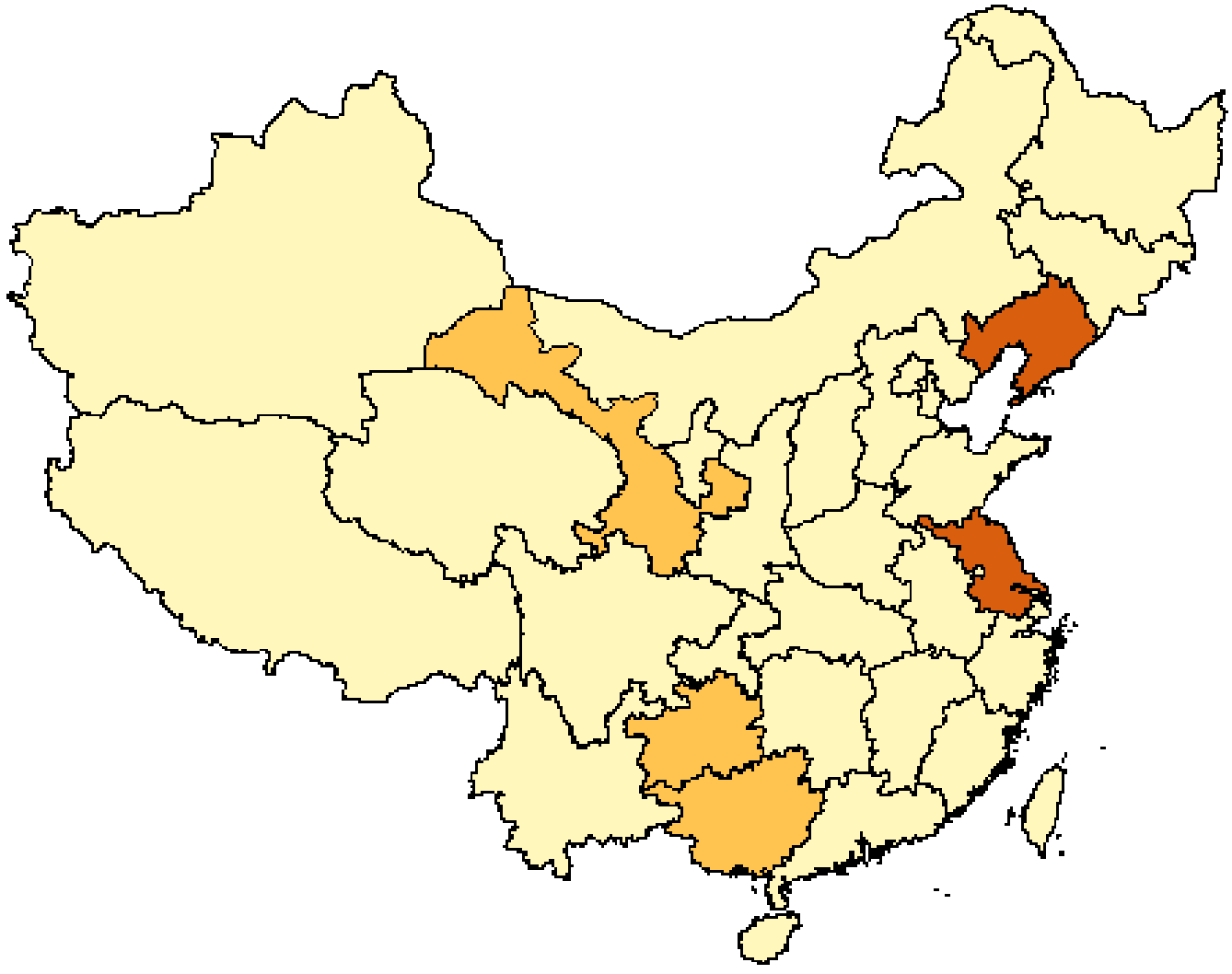
China's uneven development

- Development in China often mistaken for development in the coastal provinces: **will China transform itself from an imitator to an innovator?** (Eberhardt, Helmers, & Yu, 2011)
- Inequality: **concerns among policy-makers**
  → 'Great Western Development Strategy' (since 2000).

The idea for this paper

- Stylised facts about **manufacturing firms in Africa** (various CSAE studies, Frazer, 2005; Van Biesebroeck, 2005)
  - Recent shift in **size distribution** towards micro firms.
  - Only **large firms** are exporters/internationally competitive; **more productive** than small firms (Y/L, TFP).
  - **Large firms survive and grow** larger, small firms don't.
  - In Africa **'large' means more than 100 workers**.
  - **Technology heterogeneity** between Ghanaian and Korean firms (Baptist & Teal, 2008b): material input. Homothetic technology→technology shift required!
  - **Productivity dispersion** (TFP) similar to developed economies; large firms face **relatively larger labour costs**, use **excessively capital-intensive technology** (Söderbom & Teal, 2004).
- **Initial empirical exercise**
  - What about firms in China? **Within China analysis** comparing three 'backward' provinces with two more advanced ones. ★ Focus of this presentation. Note: no African firms analysed.
  - **Next step**: address the title question.

Provinces of interest



Guizhou, **Gansu** and **Guangxi** (poor), **Liaoning** (intermediate), **Jiangsu** (rich)

Illustrative comparison

- **Five Chinese Provinces** (2010 census)

Rank	Province	Pop	GDP pc
#4	**Jiangsu**	79m	$13,178
#8	**Liaoning**	43m	$10,589
#26	**Guangxi**	46m	$5,232
#29	**Gansu**	26m	$4,082
#31	**Guizhou**	35m	$3,351

- **Four African Economies** (PWT 7.0, 2011)

	Country	Pop	GDP pc
	Ghana	24m	$1,240
	Kenya	39m	$1,205
	Tanzania	41m	$1,189
	Ethiopia	85m	$684

Notes: GDP figures are PPP, rank is based on Chinese GDP pc.

ASIE firm-level data

- **NBS dataset** used in many China-related studies (e.g. Brandt et al, 2010, papers presented here).
- In the present version data for **1999-2007**.
- **Production data** — deflated using sector-level output and investment deflators (wage cost = firm expense, applied investment deflator).
- **Data for 5 Provinces**: substantial differences in sample size — 'backward' provinces have more small enterprises?!?
- **Ownership type** by majority share (Guariglia et al, 2011).
- **Affiliation** to central, provincial, etc. government.
- 3-digit **sector dummies** as well as **year dummies**.
- For some descriptives **split samples** into four 'equal' parts (all 5 provinces), based on worker headcount. Size 1: $L <= 56$; 2: $56 < L <= 110$; 3: $110 < L <= 232$; 4: $L > 232$. Note that in SSA a large firm has 100 workers.

Conditional Means for four size groups (i)

Province	Obs	1>2	2>3	3>4	Test	2 vs 1	3 vs 1	4 vs 1
Output per worker (in logs)								
Guizhou	8,523	+	+	−	0.00	95%	84%	85%
Gansu	11,697	+	+	+	0.00	70%	57%	54%
Guangxi	13,791	+	+	−	0.00	81%	64%	65%
Liaoning	45,912	+	+	+	0.00	62%	50%	44%
Jiangsu	181,550	+	+	+	0.00	66%	55%	52%
VA per worker (in logs)								
Guizhou	8,523	+	+	−	0.50	96%	85%	88%
Gansu	11,697	+	+	+	0.00	70%	57%	53%
Guangxi	13,791	+	+	−	0.00	81%	64%	65%
Liaoning	45,912	+	+	+	0.00	64%	52%	47%
Jiangsu	181,550	+	+	+	0.00	68%	57%	55%
Capital per worker (in logs)								
Guizhou	8,523	+	−	−	0.00	91%	94%	103%
Gansu	11,697	+	+	−	0.00	94%	87%	98%
Guangxi	13,791	+	+	−	0.00	89%	86%	92%
Liaoning	45,912	+	+	−	0.00	85%	77%	78%
Jiangsu	181,550	+	+	−	0.00	82%	78%	90%

Notes: Size 1: $L <= 56$; 2: $56 < L <= 110$; 3: $110 < L <= 232$; 4: $L > 232$. Condition on ownership, sector, year.

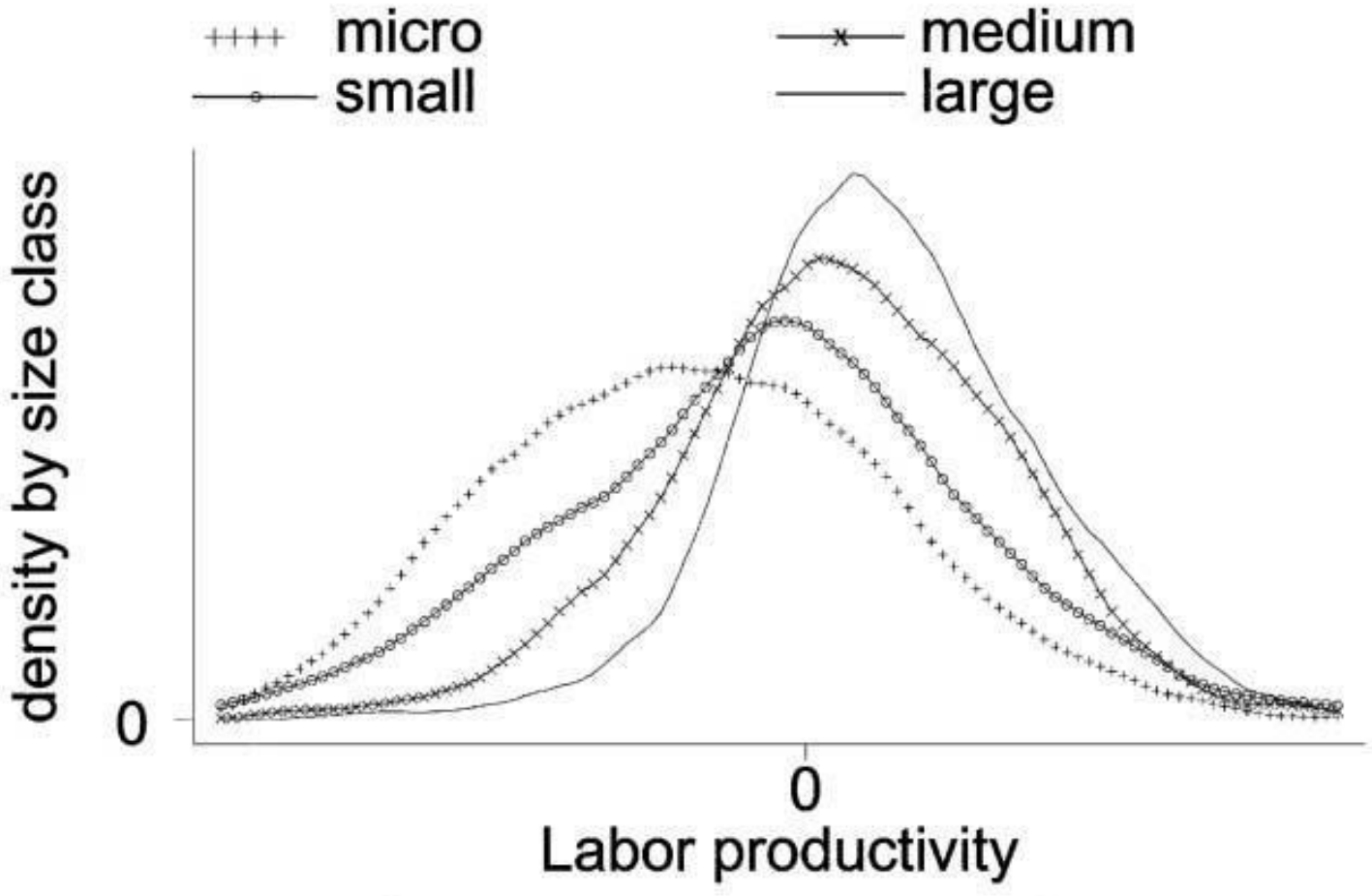
Conditional Means for four size groups (ii)

Province	Obs	1>2	2>3	3>4	Test	2 vs 1	3 vs 1	4 vs 1
Materials per worker (in logs)								
Guizhou	8,523	+	+	−	0.00	96%	85%	86%
Gansu	11,697	+	+	−	0.00	69%	56%	56%
Guangxi	13,791	+	+	−	0.00	81%	64%	67%
Liaoning	45,912	+	+	+	0.00	61%	50%	44%
Jiangsu	181,550	+	+	+	0.08	66%	55%	51%
Wage cost per worker (in logs)								
Guizhou	7,718	+	−	−	0.00	98%	99%	111%
Gansu	9,938	+	+	−	0.00	91%	89%	106%
Guangxi	13,144	−	+	−	0.02	102%	99%	115%
Liaoning	43,393	+	+	−	0.00	100%	98%	99%
Jiangsu	171,619	+	+	−	0.00	98%	97%	99%
VA-Output ratio								
Guizhou	8,523	+	+	−	0.00			
Gansu	11,697	−	−	+	0.00			
Guangxi	13,791	−	−	+	0.00			
Liaoning	45,912	−	−	−	0.00			
Jiangsu	181,550	−	−	−	0.00			

Notes: Size 1: $L <= 56$; 2: $56 < L <= 110$; 3: $110 < L <= 232$; 4: $L > 232$. Condition on ownership, sector, year.

Unconditional labour productivity

Kernel density estimates for nine Sub-Saharan African countries taken from Van Biesebroeck (2005).



Cobb-Douglas and Translog Production Functions

- **Cobb-Douglas (CD)**: strong assumptions about homotheticity (technology heterogeneity by size ruled out)
- **Translog (TL)**: Output elasticities can vary with size, level of factor inputs (materials) or factor combinations. Variety of tests at our disposal.
- **Gross output** production functions (Bruno, 1984; Basu & Fernald, 1995, 1995).
- **Covariates** include factor inputs, ownership dummies (majority shareholder following Guariglia et al, 2011), indicators for government affiliation, exporter dummy, year dummies and 3-digit sector dummies.
- **Firm-data analysis is challenging** (Eberhardt & Helmers, 2010), particularly so in the case of China: OP, LP, SGMM all display serious distortions (RTS .5, $\sum \beta_k >> 1$, $\beta_k < 0$ etc. — see next slide). Limit regression analysis to OLS/FE in the present case.

Levinsohn and Petrin (2003) VA CD Production Functions

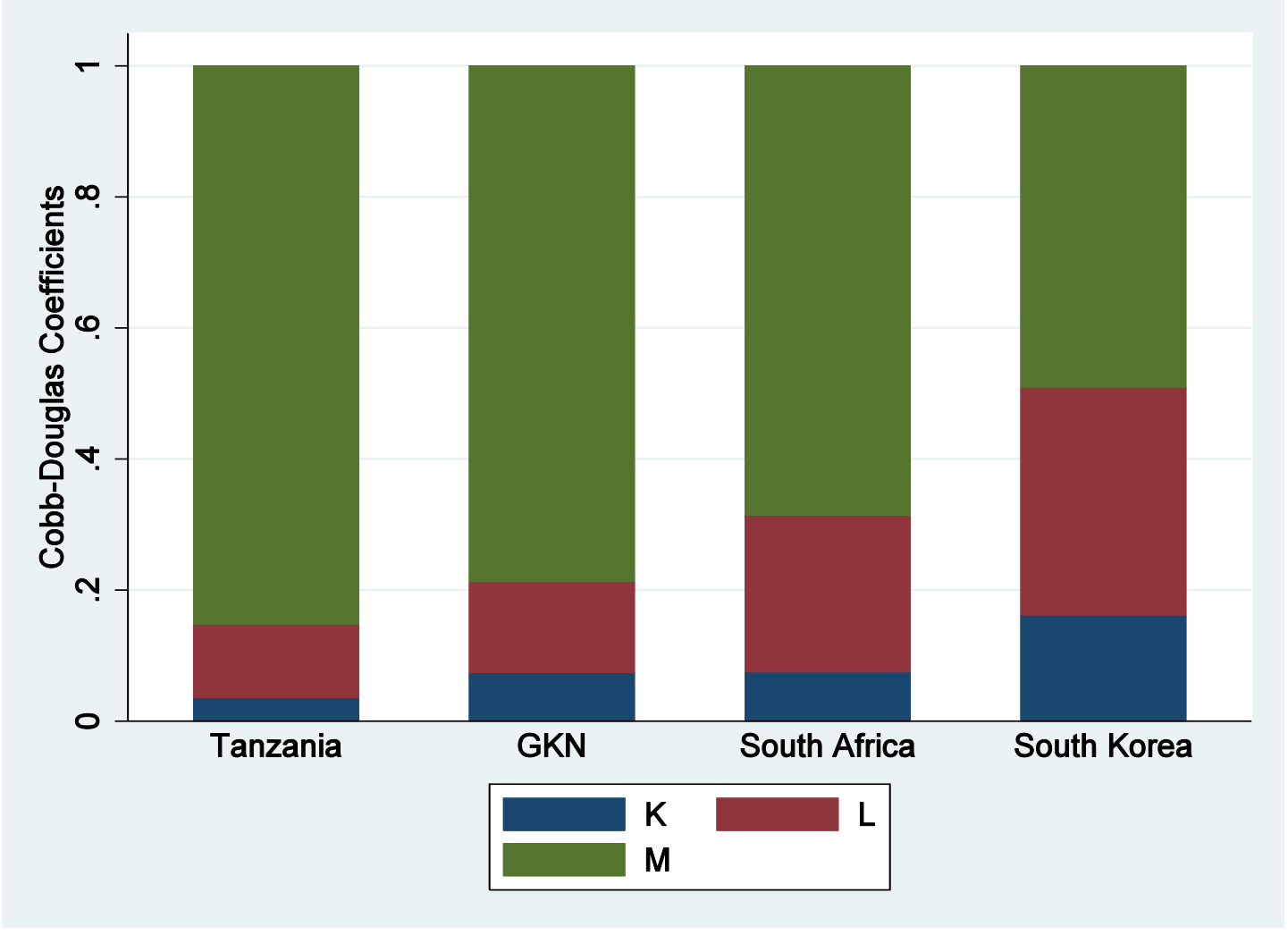
	Guizhou	Gansu	Guangxi	Liaoning	Jiangsu
Food Processing					
Labour (log)	0.112	0.140	0.108	0.069	-0.004
	[0.059]*	[0.036]***	[0.043]**	[0.018]***	[0.011]
Capital (log)	0.161	0.269	0.194	0.172	0.184
	[0.063]**	[0.069]***	[0.048]***	[0.019]***	[0.021]***
RTS	0.273	0.409	0.302	0.241	0.180
Obs	716	1304	1682	3773	5992
Food Manufacture					
Labour (log)	0.103	0.147	0.082	0.096	0.036
	[0.056]*	[0.046]***	[0.066]	[0.035]***	[0.029]
Capital (log)	0.083	0.170	0.175	0.154	0.188
	[0.091]	[0.068]**	[0.064]***	[0.054]***	[0.038]***
RTS	0.186	0.317	0.257	0.250	0.224
Obs	270	580	482	1210	2083
Beverage Manufacture					
Labour (log)	0.017	0.079	0.257	0.151	0.128
	[0.055]	[0.069]	[0.094]***	[0.042]***	[0.036]***
Capital (log)	0.037	0.292	0.200	0.042	0.154
	[0.069]	[0.102]***	[0.118]*	[0.055]	[0.051]***
RTS	0.054	0.371	0.457	0.193	0.282
Obs	510	447	431	750	1380

Cobb-Douglas Estimates (GO): Marginal Effects

	Guizhou	Gansu	Guangxi	Liaoning	Jiangsu
Labour (log)	0.051	0.097	0.080	0.058	0.039
	[0.006]***	[0.012]***	[0.007]***	[0.003]***	[0.001]***
Capital (log)	0.022	0.060	0.043	0.040	0.030
	[0.003]***	[0.006]***	[0.004]***	[0.002]***	[0.001]***
Material (log)	0.919	0.783	0.841	0.865	0.917
	[0.007]***	[0.017]***	[0.010]***	[0.005]***	[0.002]***
$\beta_L + \beta_K + \beta_M$	0.992	0.940	0.964	0.963	0.986
FIE(other)	0.020	0.128	0.124	0.084	0.057
	[0.029]	[0.048]***	[0.022]***	[0.010]***	[0.005]***
FIE(HMT)	0.040	0.151	0.097	0.101	0.029
	[0.020]**	[0.069]**	[0.018]***	[0.013]***	[0.005]***
Private	0.037	0.053	0.106	0.035	0.010
	[0.009]***	[0.015]***	[0.013]***	[0.008]***	[0.004]**
Collective	0.009	0.027	0.083	0.022	0.016
	[0.011]	[0.015]*	[0.015]***	[0.009]***	[0.004]***
Other	0.019	0.028	0.124	0.075	0.035
	[0.018]	[0.017]	[0.024]***	[0.013]***	[0.005]***
Exporter	0.021	0.052	0.000	0.022	0.006
	[0.010]**	[0.022]**	[0.011]	[0.005]***	[0.002]***
Obs	8,523	11,697	13,791	45,912	181,550
Firms	1,665	2,662	3,015	9,704	36,643
R^2	0.98	0.93	0.96	0.95	0.97

Technology coefficients in African firms

CD results taken from Baptist and Teal (2008a)



Translog Estimates (GO): Technology implications

	Guizhou	Gansu	Guangxi	Liaoning	Jiangsu
trend β_L	0.014	0.000	0.017	0.009	0.007
	[0.002]***	[0.003]	[0.002]***	[0.001]***	[0.000]***
trend β_K	0.004	0.011	0.005	0.002	0.002
	[0.001]***	[0.002]***	[0.001]***	[0.001]***	[0.000]***
trend β_M	-0.016	-0.018	-0.029	-0.016	-0.010
	[0.002]***	[0.005]***	[0.002]***	[0.001]***	[0.001]***
lnLlnK	0.006	0.027	0.008	0.012	0.013
	[0.003]*	[0.005]***	[0.004]**	[0.002]***	[0.001]***
lnLlnM	-0.042	-0.073	-0.073	-0.053	-0.044
	[0.009]***	[0.014]***	[0.010]***	[0.004]***	[0.003]***
lnKlnM	-0.010	-0.078	-0.022	-0.038	-0.034
	[0.005]**	[0.008]***	[0.006]***	[0.003]***	[0.002]***
MPK	5.8%	8.8%	13.8%	12.6%	15.5%
MPL	3,296	3,669	6,058	7,274	7,188
EIU 1998	6,193		6,153		7,398
MPM	1.336	1.273	1.318	1.311	1.277
Hicks	0.00	0.00	0.00	0.00	0.00
RTS change	0.002	-0.007	-0.007	-0.005	-0.001
C-D	0.00	0.00	0.00	0.00	0.00
Homog	0.08	0.00	0.11	0.00	0.00
Degree-H	0.89	0.95	0.88	0.64	0.80
Degree-1	0.02	0.00	0.03	0.00	0.00

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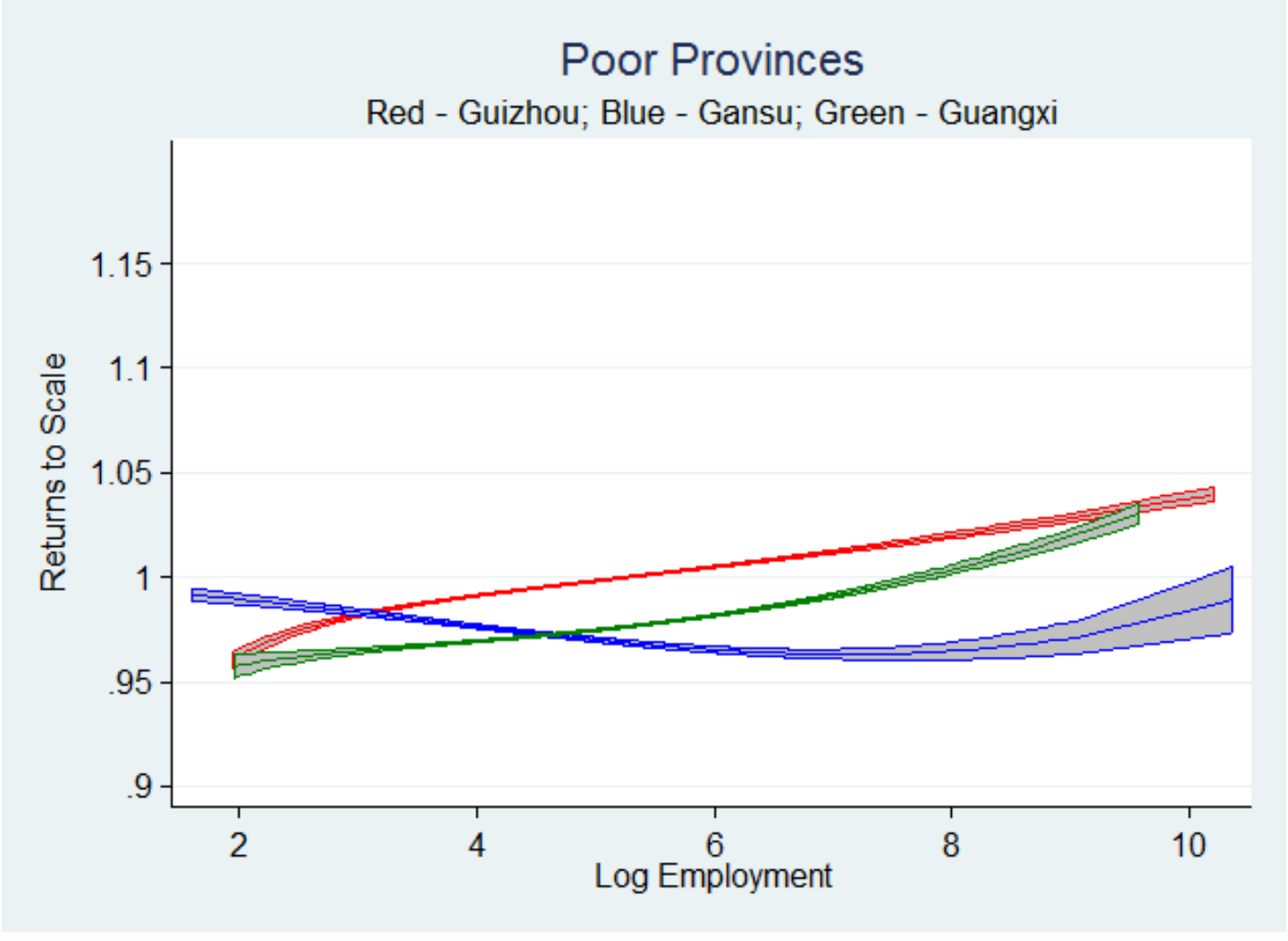
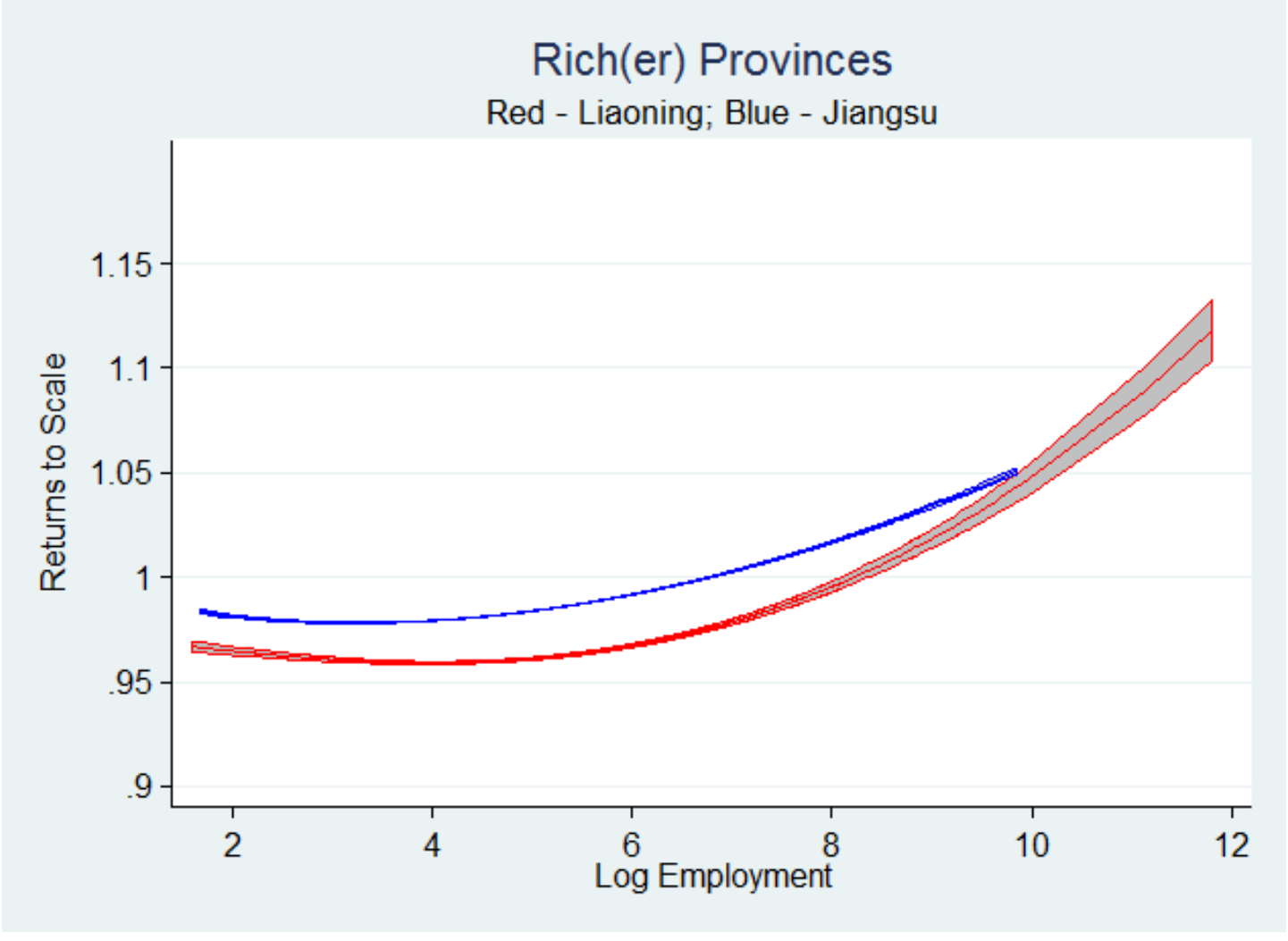
Returns to Scale (i)

Returns to scale at the firm level across three poor provinces (OLS GO; GZ & GX reject homotheticity → common RTS)



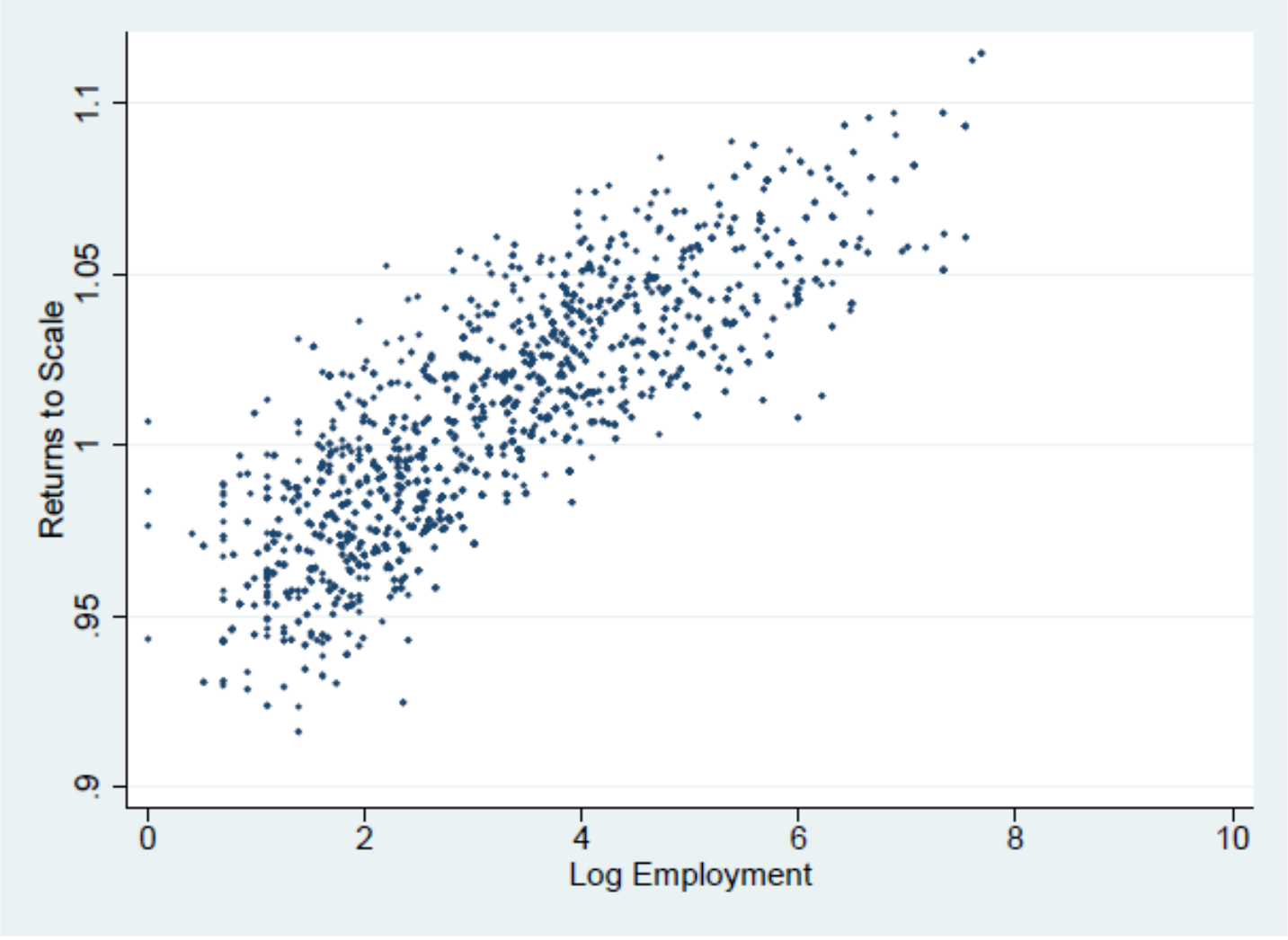
Returns to Scale (ii)

Returns to scale at the firm level across two rich(er) provinces (OLS translog results, gross output specification)



Returns to Scale in Tanzania

Taken from Baptist (2008) based on GO-TL OLS/FE (?) regressions of $N = 302$ firms.



Translog Estimates (GO): Marginal Effects

	Guizhou	Gansu	Guangxi	Liaoning	Jiangsu
Labour (log)	0.050	0.070	0.070	0.053	0.041
	[0.006]***	[0.009]***	[0.007]***	[0.003]***	[0.001]***
Capital (log)	0.024	0.053	0.042	0.040	0.029
	[0.004]***	[0.005]***	[0.004]***	[0.002]***	[0.001]***
Material (log)	0.924	0.851	0.864	0.872	0.915
	[0.006]***	[0.008]***	[0.006]***	[0.003]***	[0.002]***
$\beta_L + \beta_K + \beta_M$	0.998	0.974	0.976	0.964	0.985
FIE (other)	0.019	0.103	0.078	0.101	0.059
	[0.026]	[0.050]**	[0.020]***	[0.009]***	[0.005]***
FIE (HMT)	0.057	0.115	0.092	0.116	0.038
	[0.020]***	[0.057]**	[0.016]***	[0.013]***	[0.005]***
Private	0.049	0.059	0.115	0.066	0.026
	[0.009]***	[0.013]***	[0.012]***	[0.008]***	[0.004]***
Collective	0.019	0.039	0.094	0.054	0.028
	[0.011]*	[0.014]***	[0.015]***	[0.008]***	[0.004]***
Other	0.028	0.009	0.086	0.083	0.038
	[0.018]	[0.017]	[0.021]***	[0.012]***	[0.005]***
Exporter	0.016	0.041	-0.008	0.024	0.008
	[0.010]	[0.019]**	[0.010]	[0.005]***	[0.001]***
Obs	8,523	11,697	13,791	45,912	181,550
Firms	1,665	2,662	3,015	9,704	36,643
R^2	0.98	0.94	0.97	0.96	0.98

Translog Estimates (GO): Marginal Effects

	Guizhou	Gansu	Guangxi	Liaoning	Jiangsu
Labour (log)	0.050	0.070	0.070	0.053	0.041
	[0.006]***	[0.009]***	[0.007]***	[0.003]***	[0.001]***
Capital (log)	0.024	0.053	0.042	0.040	0.029
	[0.004]***	[0.005]***	[0.004]***	[0.002]***	[0.001]***
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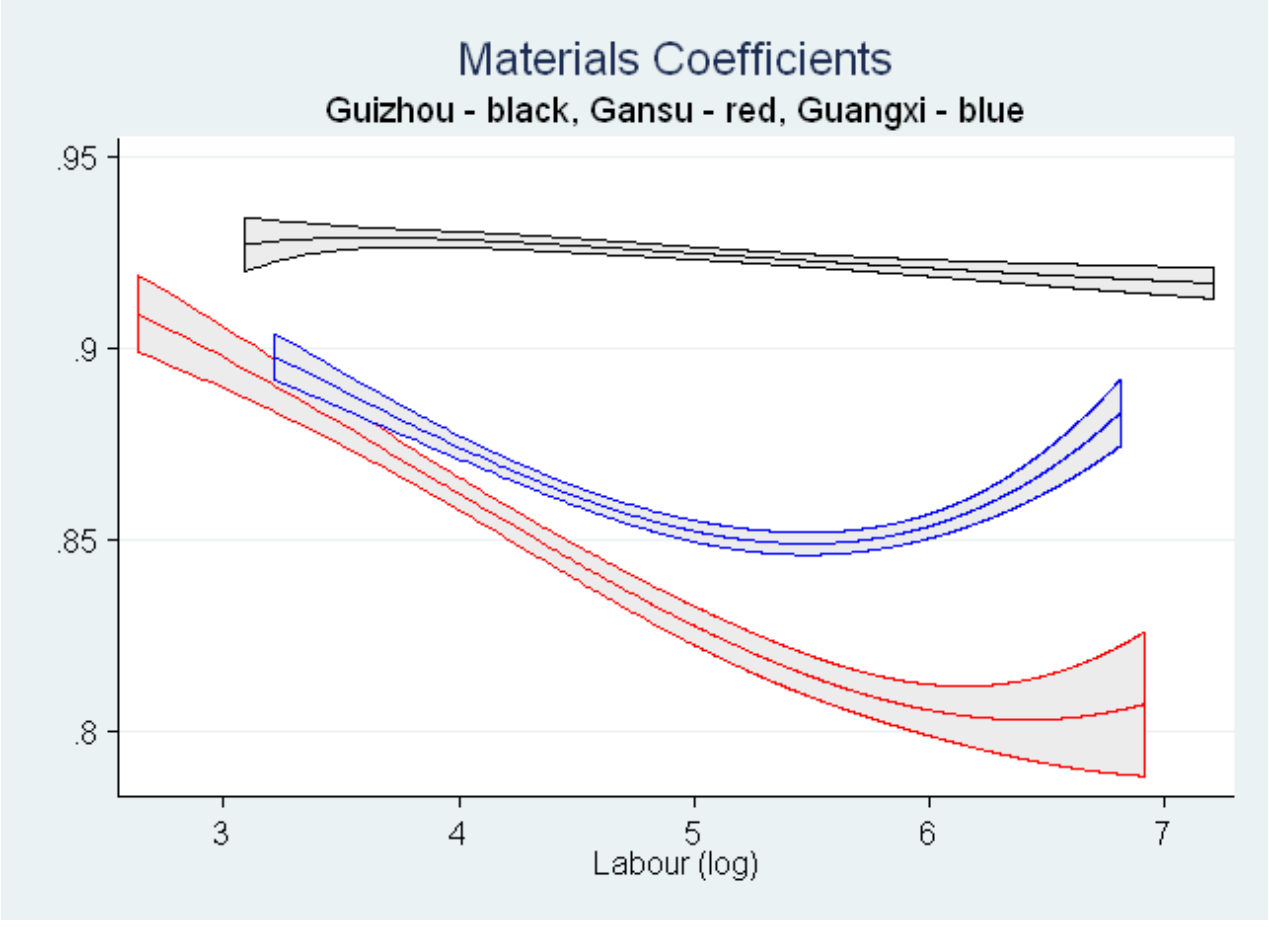
TL Estimates: Material Coefficients and Firm Size

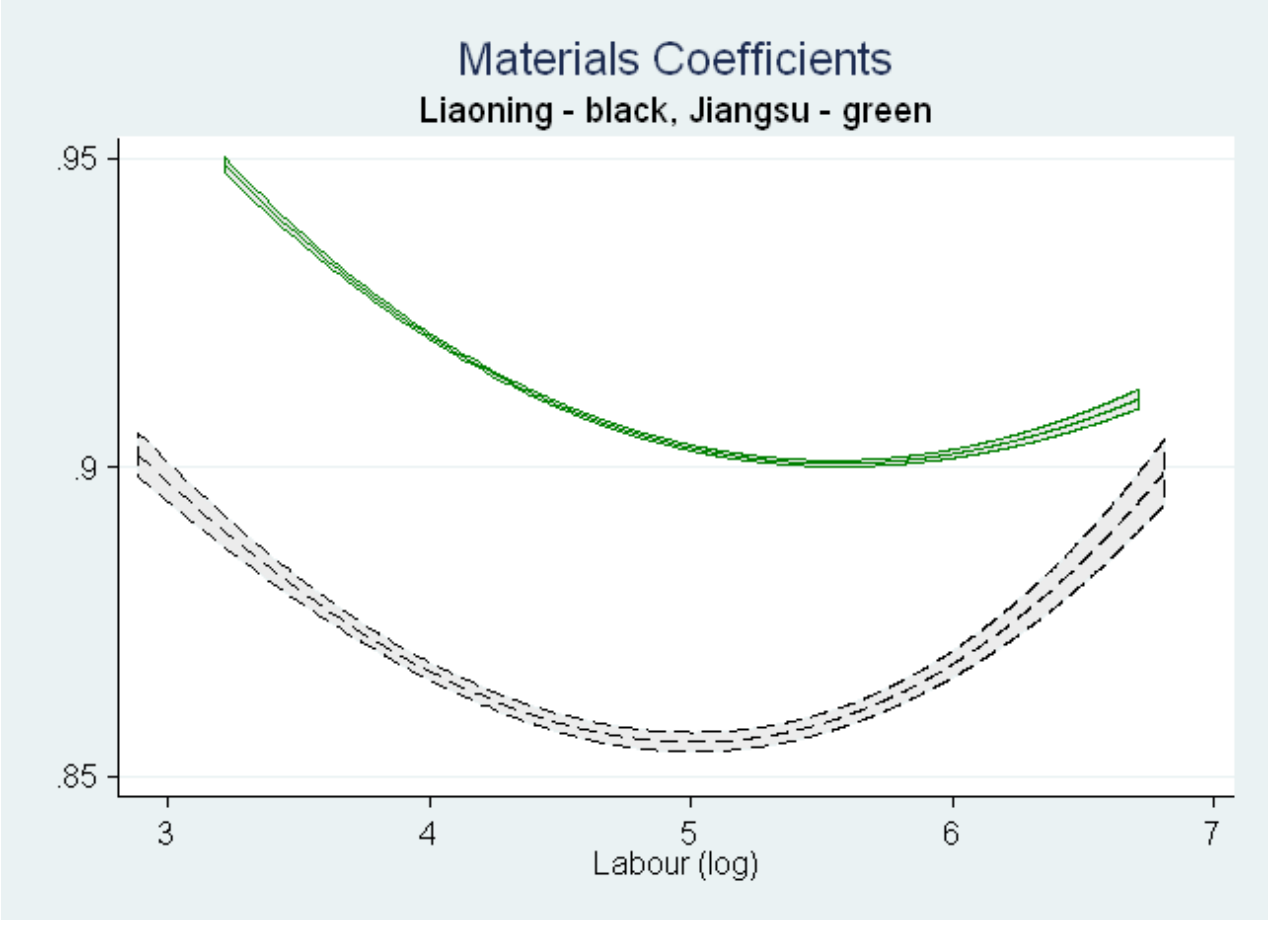
Material coefficients across firm size, three poor provinces (OLS translog results, gross output specification)



Notes: Graph excludes bottom & top 5% of observations (based on labour).

TL Estimates: Material Coefficients and Firm Size

Material coefficients across firm size, two rich(er) provinces (OLS translog results, gross output specification)



Notes: Graph excludes bottom & top 5% of observations (based on labour).

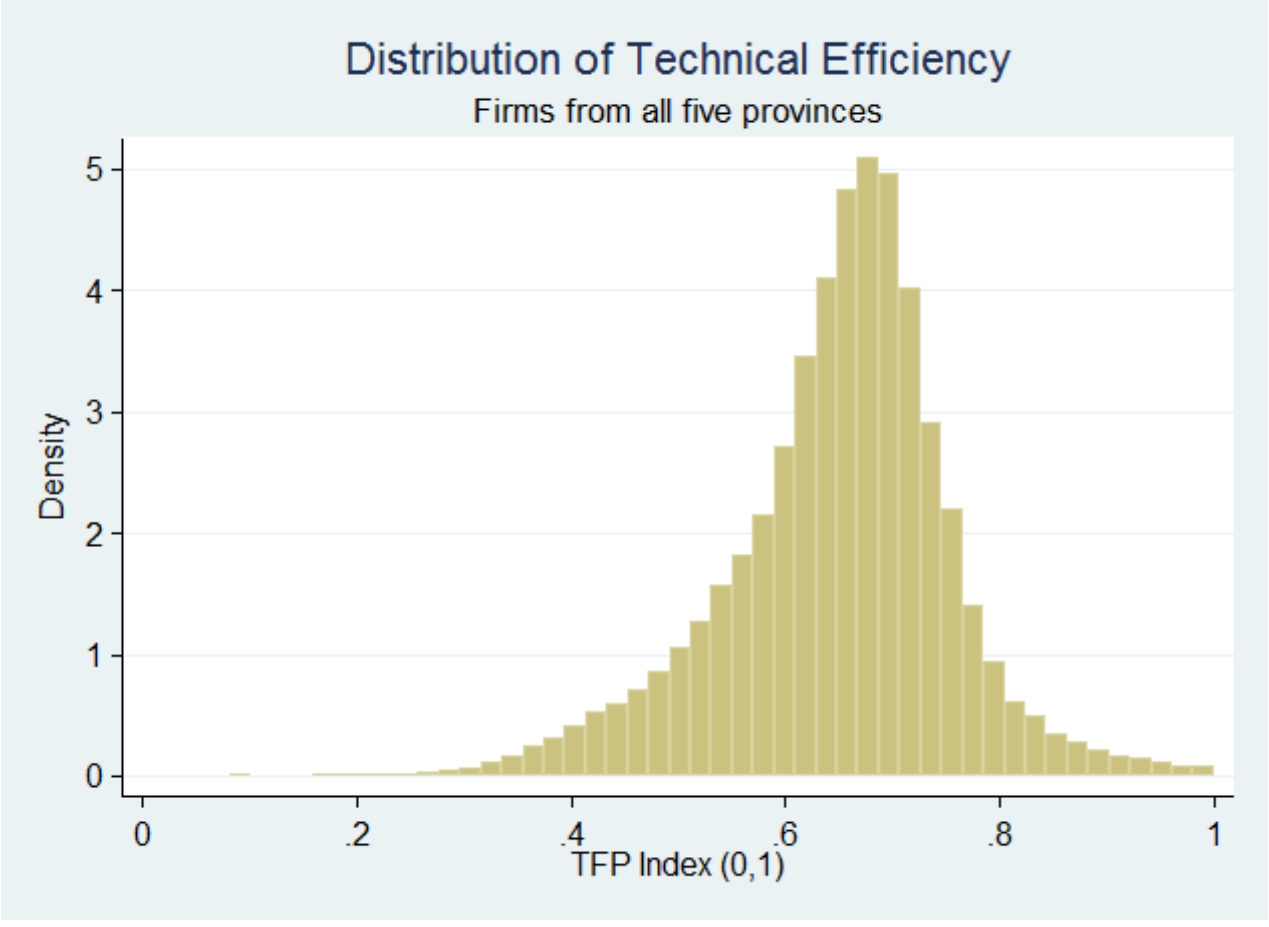
TL Estimates: Material Coefficient Evolution

	Guizhou	Gansu	Guangxi	Liaoning	Jiangsu
Year 1999	0.973	0.860	0.983	0.917	0.938
	[0.001]***	[0.004]***	[0.002]***	[0.002]***	[0.000]***
Year 2000	-0.015	-0.025	-0.026	-0.009	-0.005
	[0.001]***	[0.005]***	[0.003]***	[0.002]***	[0.001]***
Year 2001	-0.025	0.004	-0.054	-0.022	-0.011
	[0.001]***	[0.005]	[0.003]***	[0.002]***	[0.001]***
Year 2002	-0.037	0.064	-0.079	-0.034	-0.013
	[0.001]***	[0.005]***	[0.003]***	[0.002]***	[0.001]***
Year 2003	-0.052	-0.021	-0.104	-0.045	-0.019
	[0.001]***	[0.005]***	[0.003]***	[0.002]***	[0.001]***
Year 2004	-0.066	-0.034	-0.129	-0.054	-0.032
	[0.001]***	[0.007]***	[0.003]***	[0.002]***	[0.001]***
Year 2005	-0.075	-0.066	-0.150	-0.063	-0.031
	[0.002]***	[0.007]***	[0.003]***	[0.002]***	[0.001]***
Year 2006	-0.087	-0.058	-0.168	-0.060	-0.033
	[0.002]***	[0.007]***	[0.003]***	[0.002]***	[0.001]***
Year 2007	-0.089	-0.034	-0.176	-0.054	-0.030
	[0.002]***	[0.007]***	[0.003]***	[0.002]***	[0.001]***
Obs	8,523	11,697	13,791	45,912	181,550
Firms	1,665	2,662	3,015	9,704	36,643
R^2	0.44	0.08	0.37	0.05	0.04

Notes: Firm fixed effects regressions; dependent variable is the materials elasticity implied by the TL GO results.

Technical Efficiency (i)

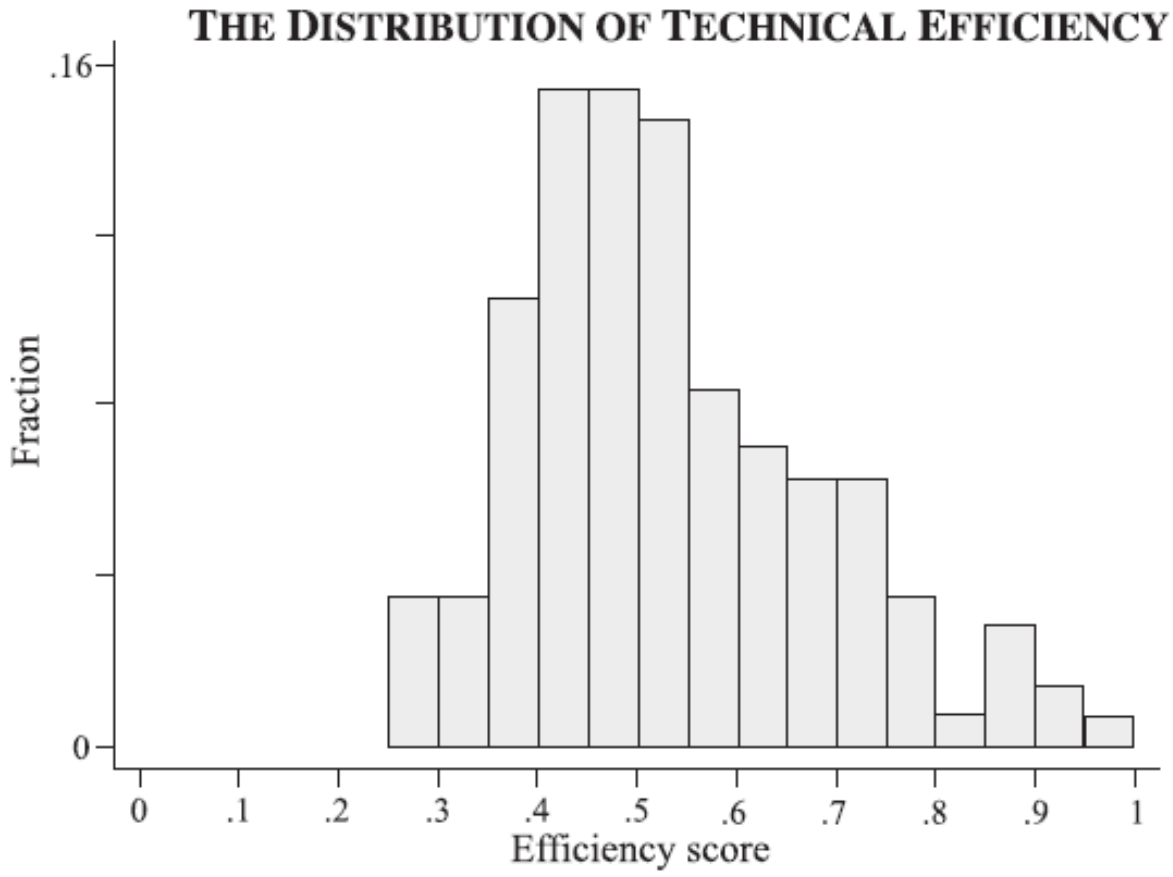
TFP level index at the firm level across five provinces
(OLS translog results, gross output specification)



Notes: Mean relative efficiency .65, standard deviation .10.

Technical Efficiency in Ghanaian firms

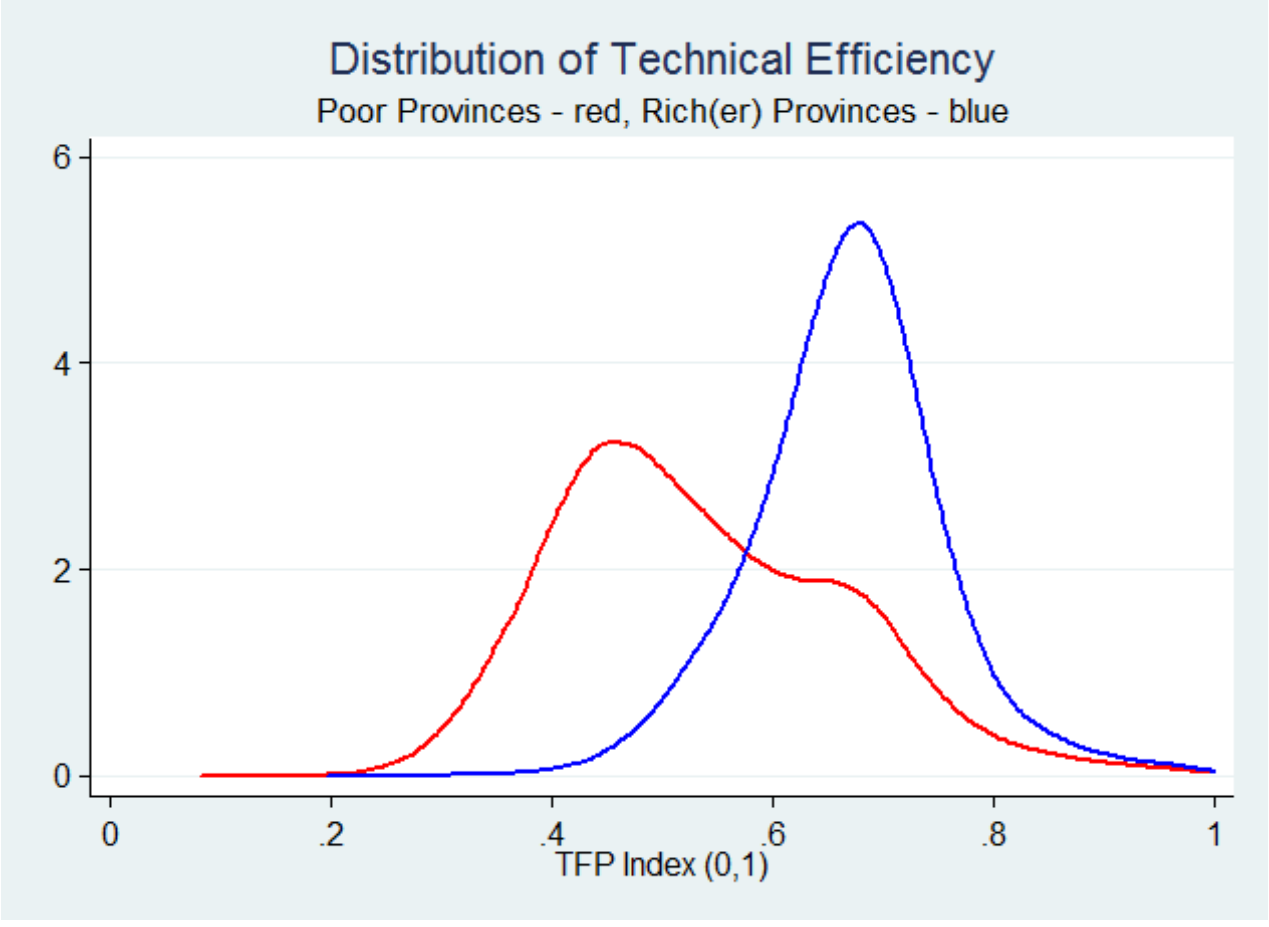
Taken from Söderbom and Teal (2004), CD-GO specification.



Notes: Mean relative efficiency .53, standard deviation .15, $N = 143$ firms. Dropping largest five FE mean rises to .6.

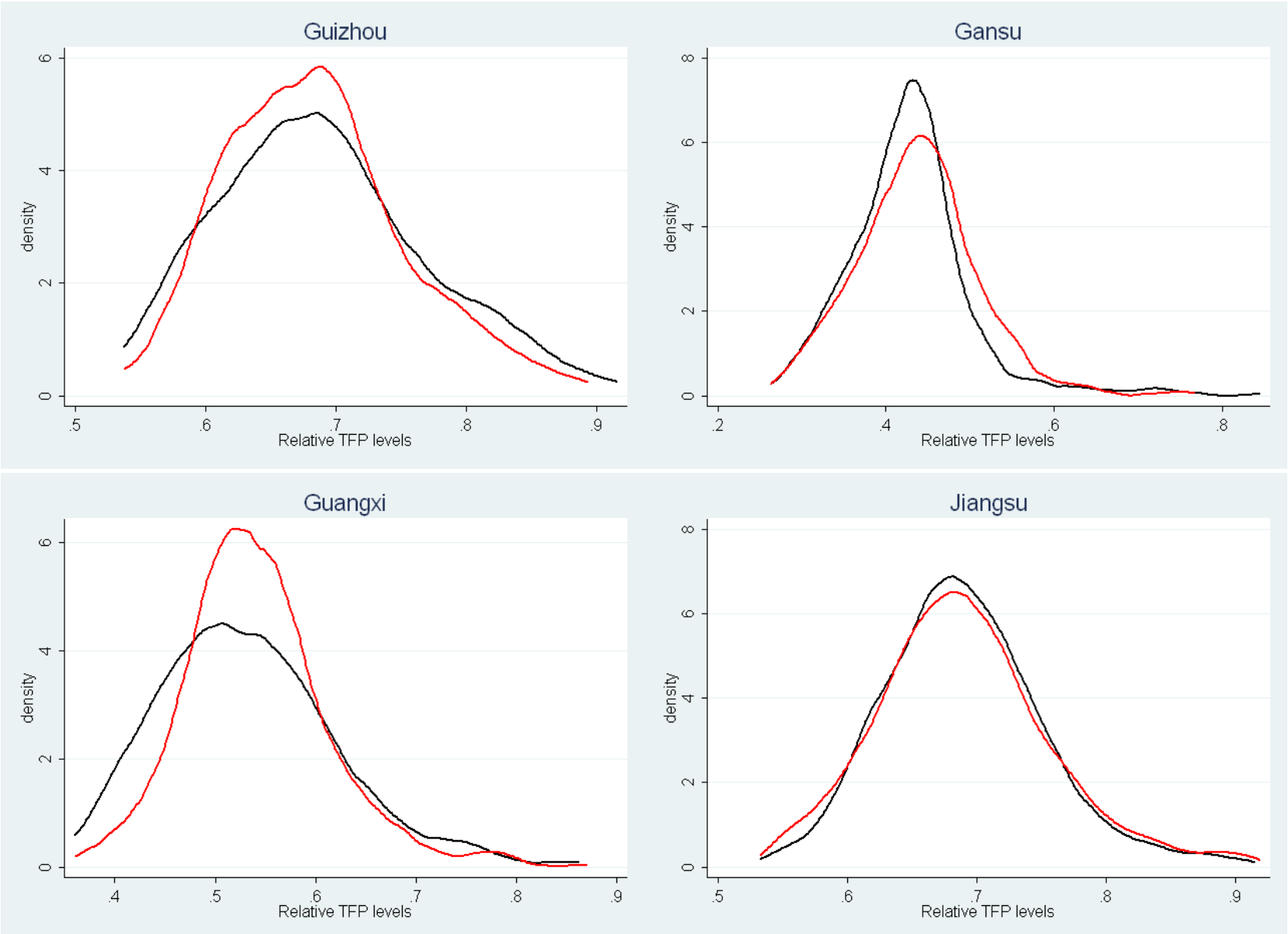
Technical Efficiency (ii)

TFP level index at the firm level across five provinces
(OLS translog results, gross output specification)



Notes: Separating out the three poor and two rich(er) provinces.
Mean (std) for poor .54 (.13), rich ($N_{poor} \times 7$) .67 (.09)

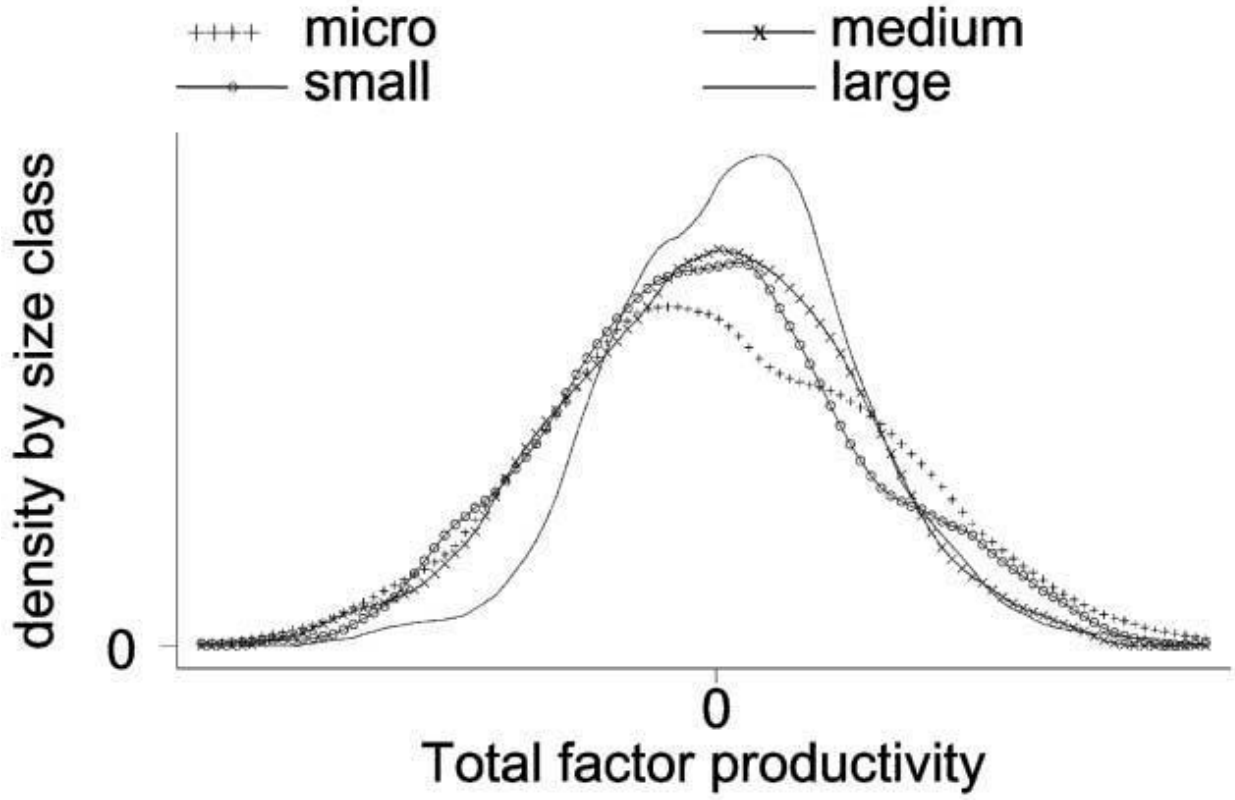
Technical Efficiency and size



Notes: Large $L > 232$ (red) and small firms $L <= 56$ only; top/bottom 1% omitted.

Technical Efficiency in Ghanaian firms

Taken from Van Biesebroeck (2005), TFP computed using wage-share data.



Capital intensity and firm size

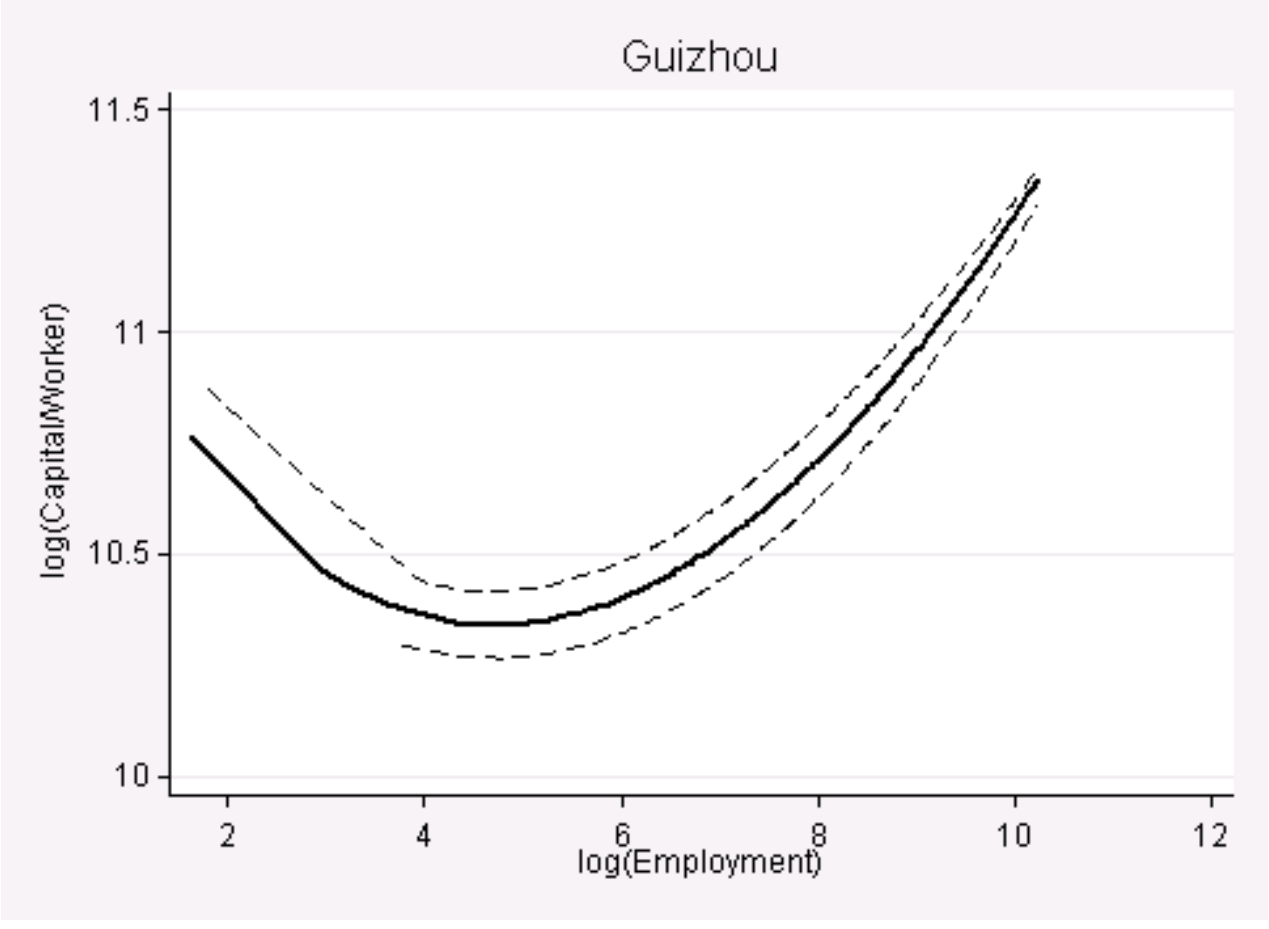
- Found nonhomothetic technology, differences in TFP level dispersion across provinces — now look specifically at factor intensity by investigating **capital-labour ratio heterogeneity** and (in the next section) wage cost heterogeneity in our sample.
- **Nonparametric approach**
  - Investigate capital-labour ratio in its relationship to firm size:

    $$ln\,k_{it} = \alpha_j + \beta_t + f(ln\,L_{it}) + \varepsilon_{it}$$

    for some (non-linear) function $f(\cdot)$.
  - Employ running line regression (conditions on all x variables simultaneously) to compute fitted values $\widehat{ln\,k}$ and standard error for every value of $ln\,L$.
  - Use fractional polynomial smoothing to plot the central tendency in the predicted values as well as the 99% confidence intervals.
- **Extension** where we adjust for labour quality (human capital) not yet implemented.

Capital intensity and firm size

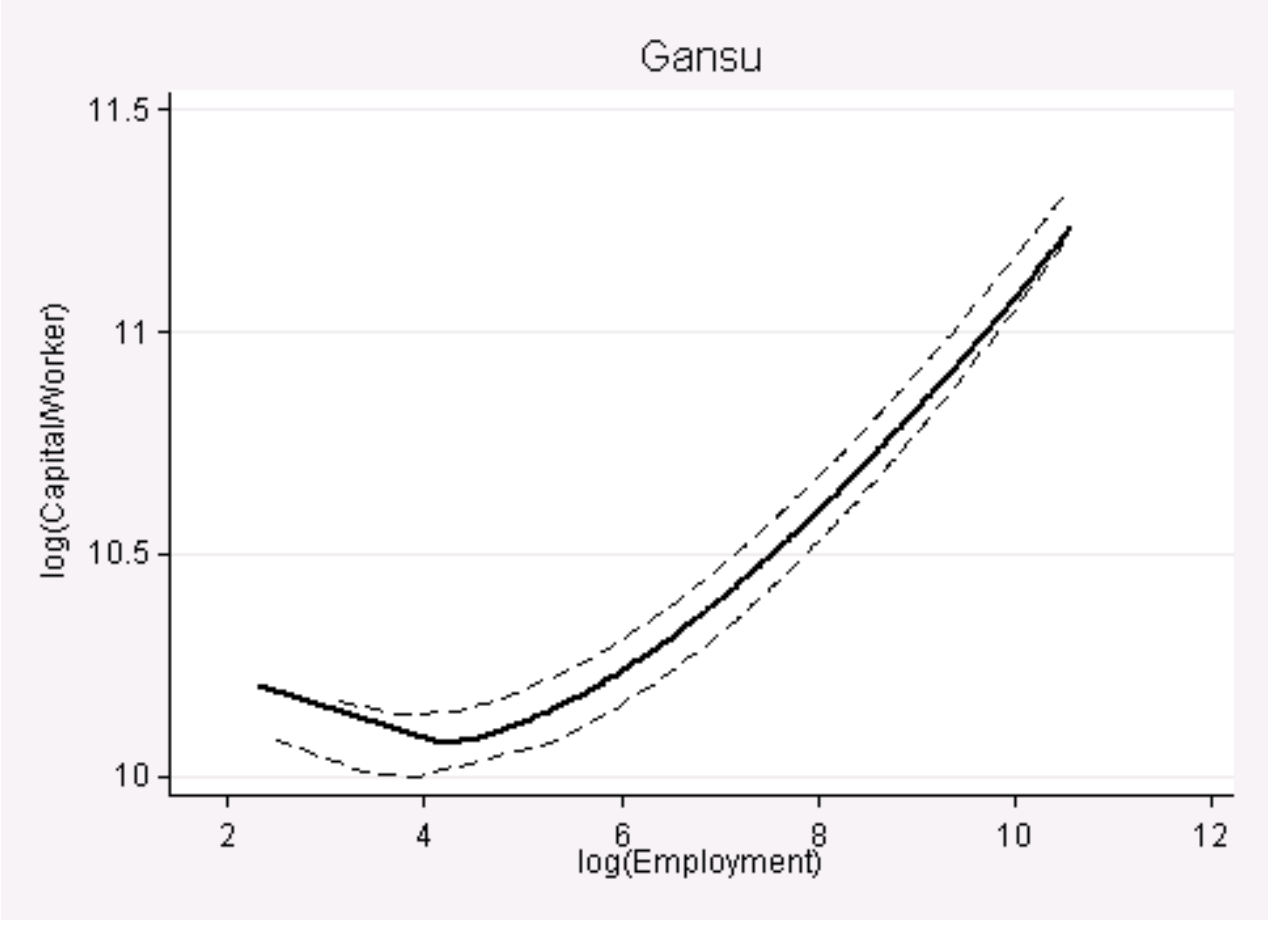
Running line regression conditioning on sector and year dummies



Notes: Running line regression prediction and 99% confidence interval. Bulk of distribution between 3 and 7.2 log Labour.

Capital intensity and firm size

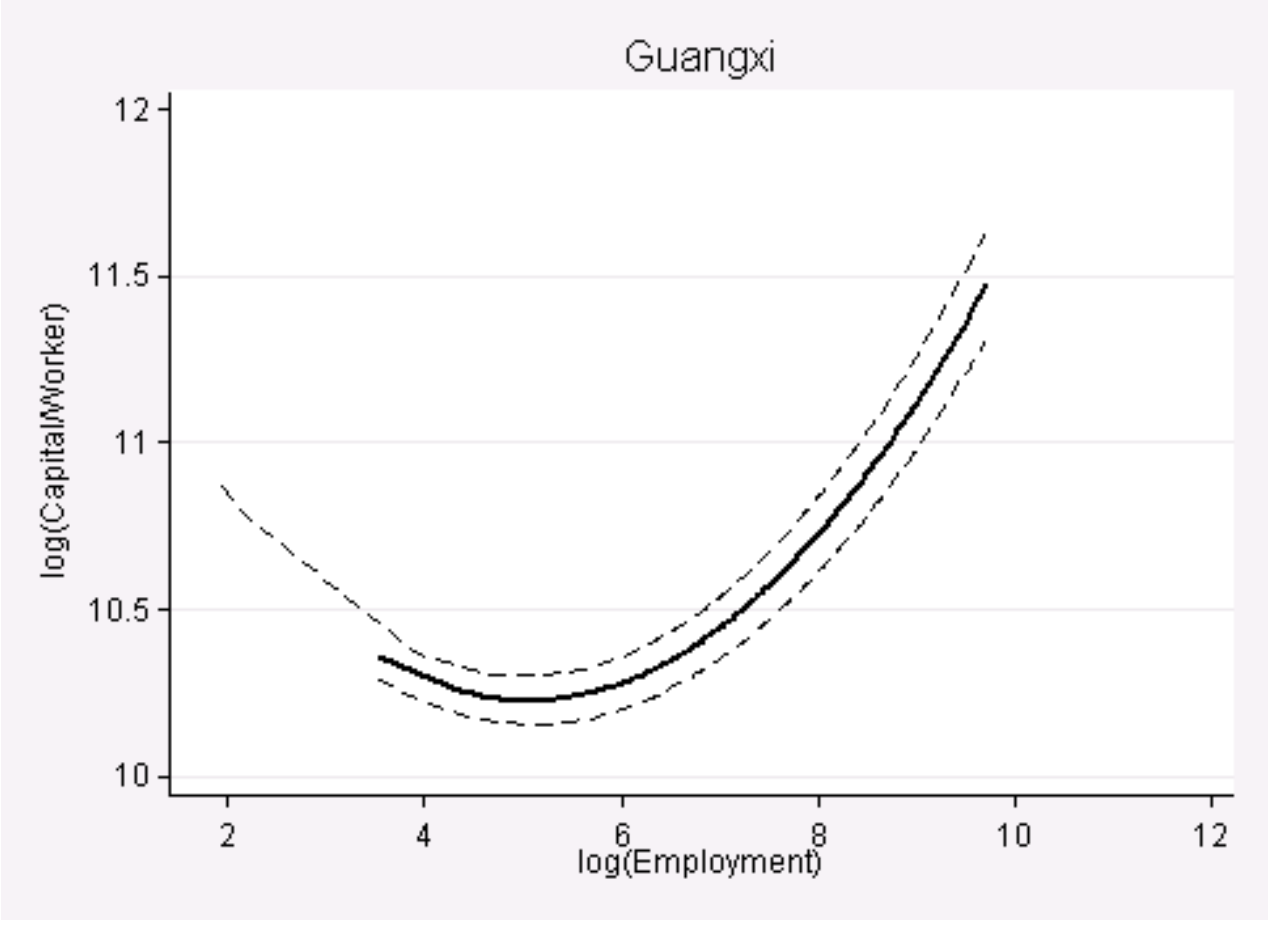
Running line regression conditioning on sector and year dummies



Notes: Running line regression prediction and 99% confidence interval. Bulk of distribution between 2.6 and 6.9 log Labour.

Capital intensity and firm size

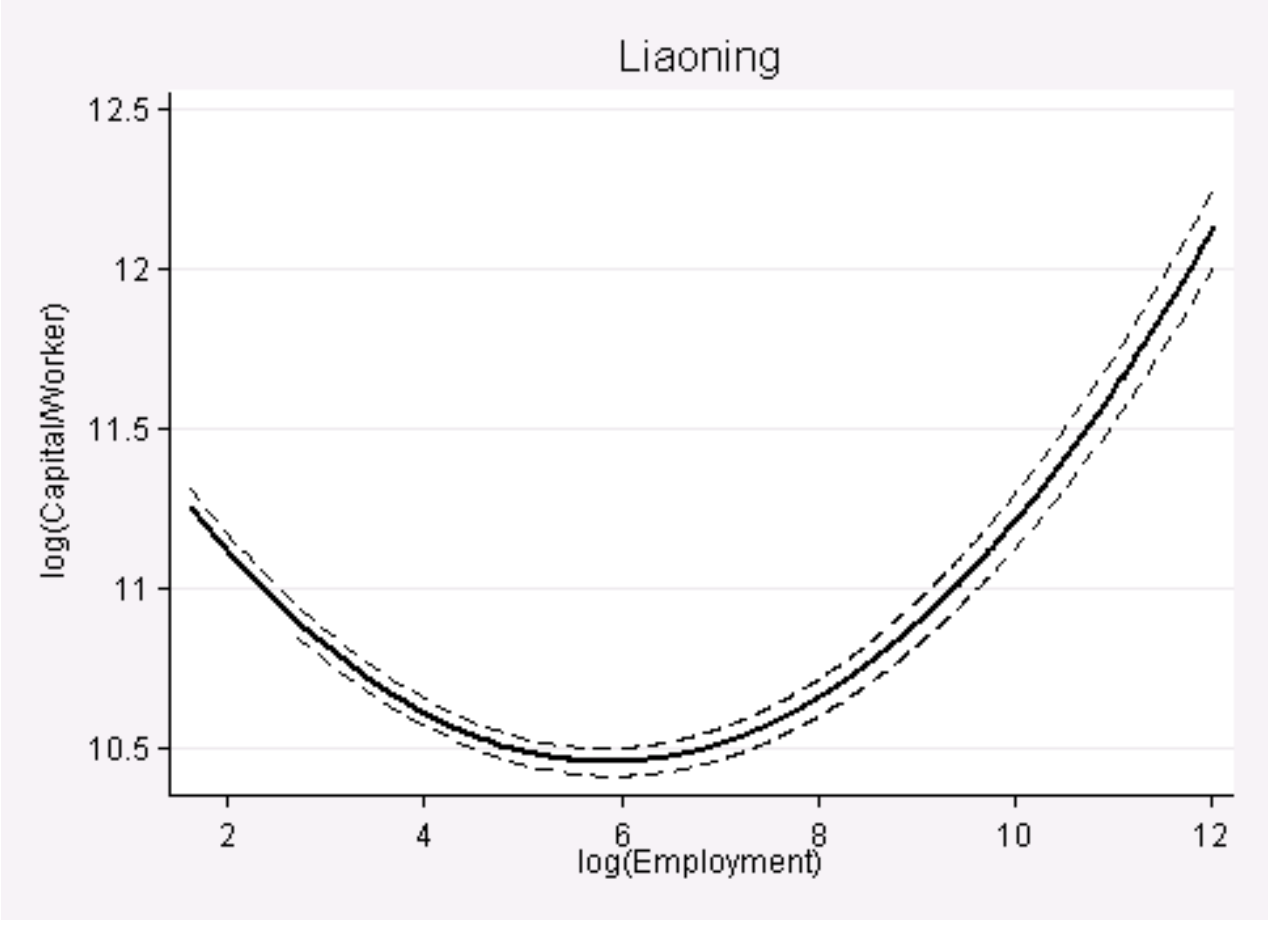
Running line regression conditioning on sector and year dummies



Notes: Running line regression prediction and 99% confidence interval. Bulk of distribution between 3.2 and 6.8 log Labour.

Capital intensity and firm size

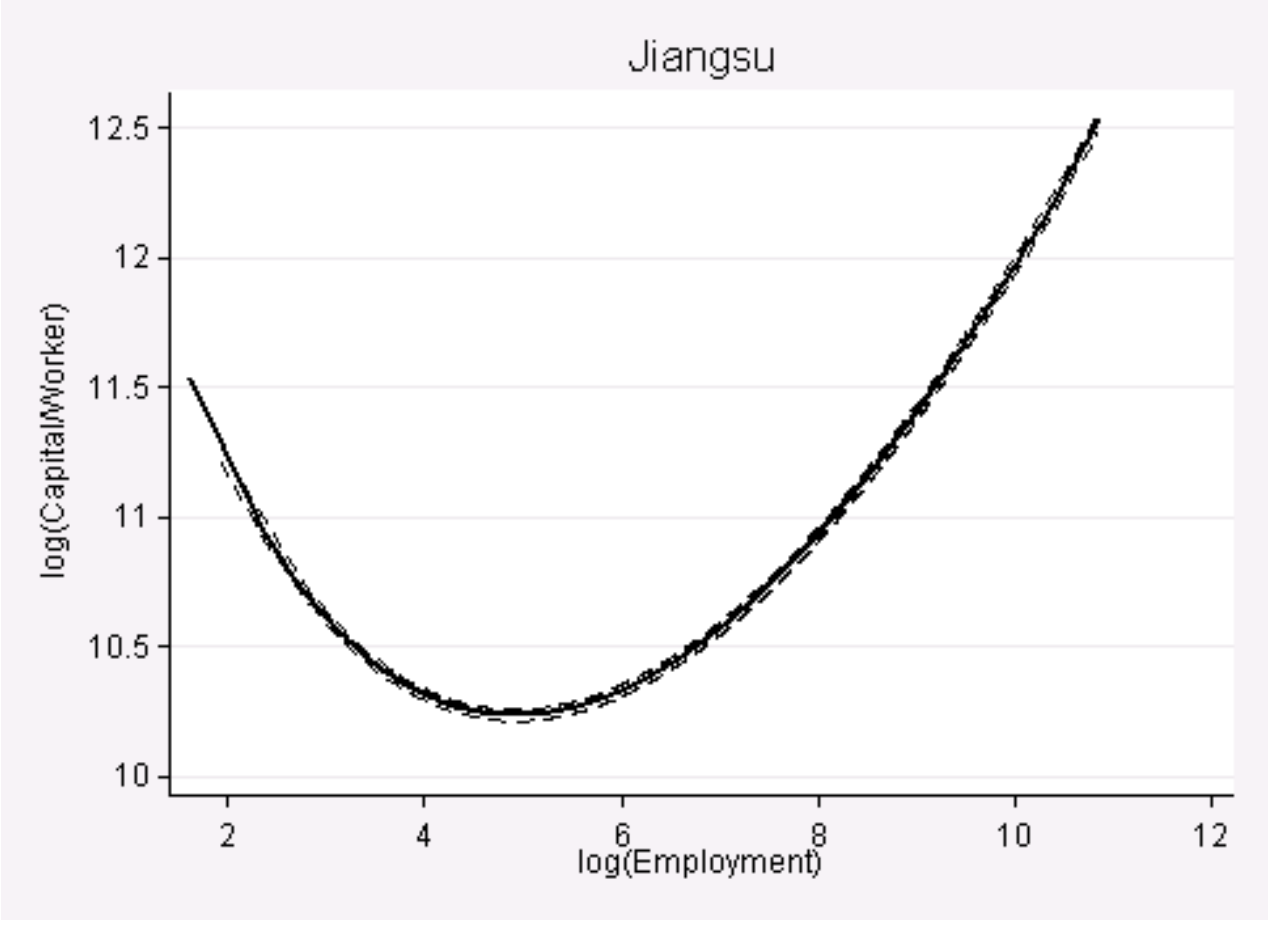
Running line regression conditioning on sector and year dummies



Notes: Running line regression prediction and 99% confidence interval. Bulk of distribution between 2.9 and 6.8 log Labour.

Capital intensity and firm size

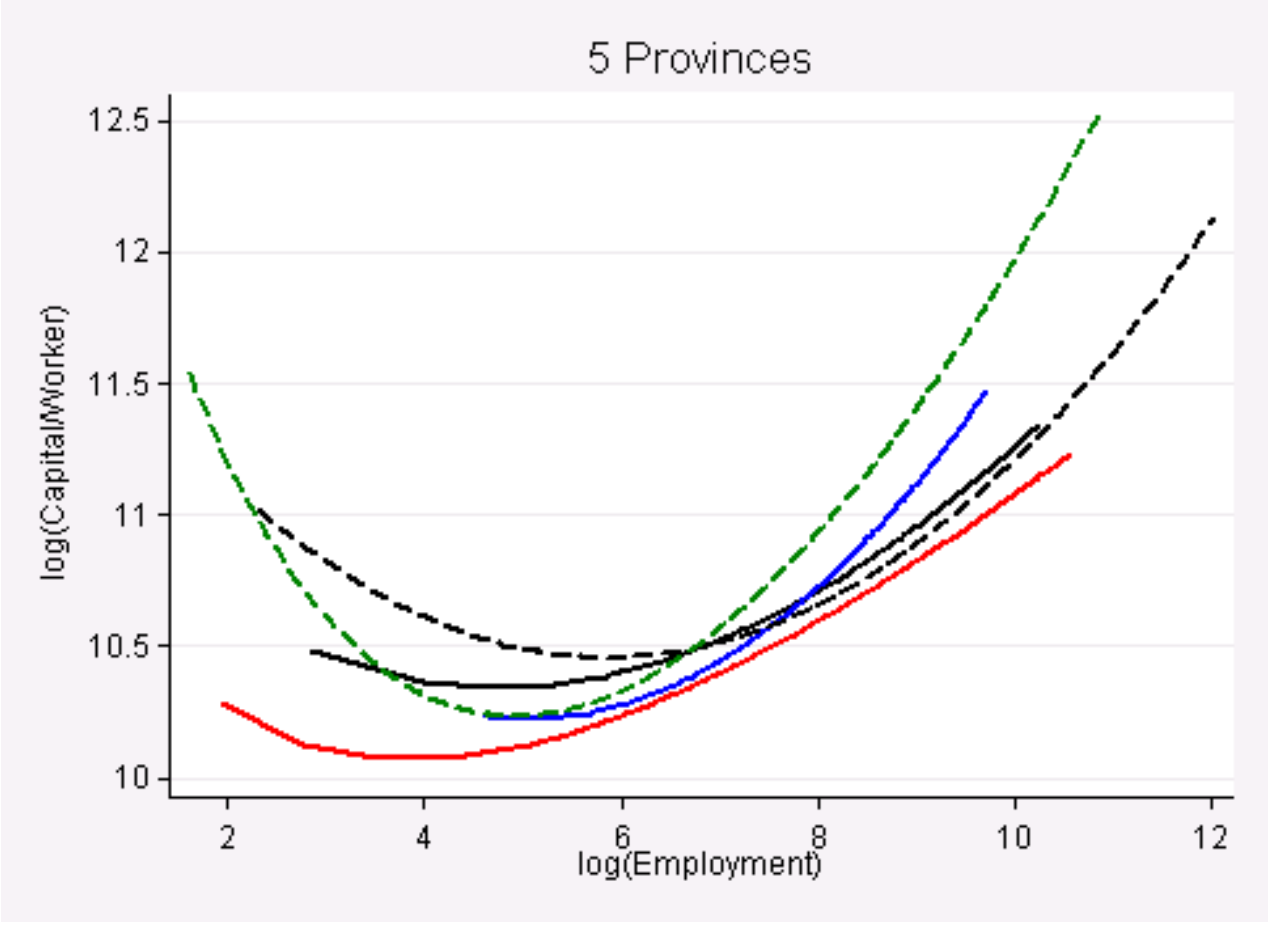
Running line regression conditioning on sector and year dummies



Notes: Running line regression prediction and 99% confidence interval. Bulk of distribution between 3.2 and 6.7 log Labour.

Capital intensity and firm size

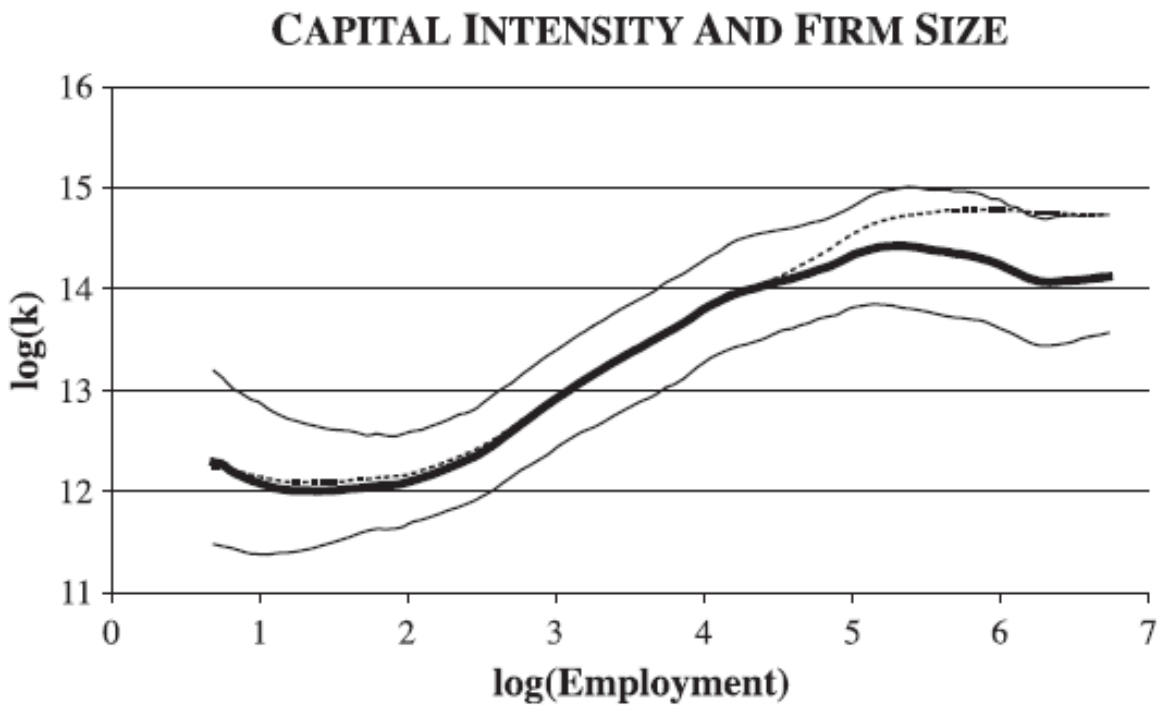
Running line regression conditioning on sector and year dummies



Notes: Running line regression prediction. Solid black, red and blue – Guizhou, Gansu, Guangxi; dashed black and green – Liaoning, Jiangsu.
[$ln4 = 54$, $ln5 = 148$, $ln6 = 403$]

Capital intensity and firm size — Ghana

Nonparametric regression (conditioned on sector, year dummies) taken from Söderbom and Teal (2004).



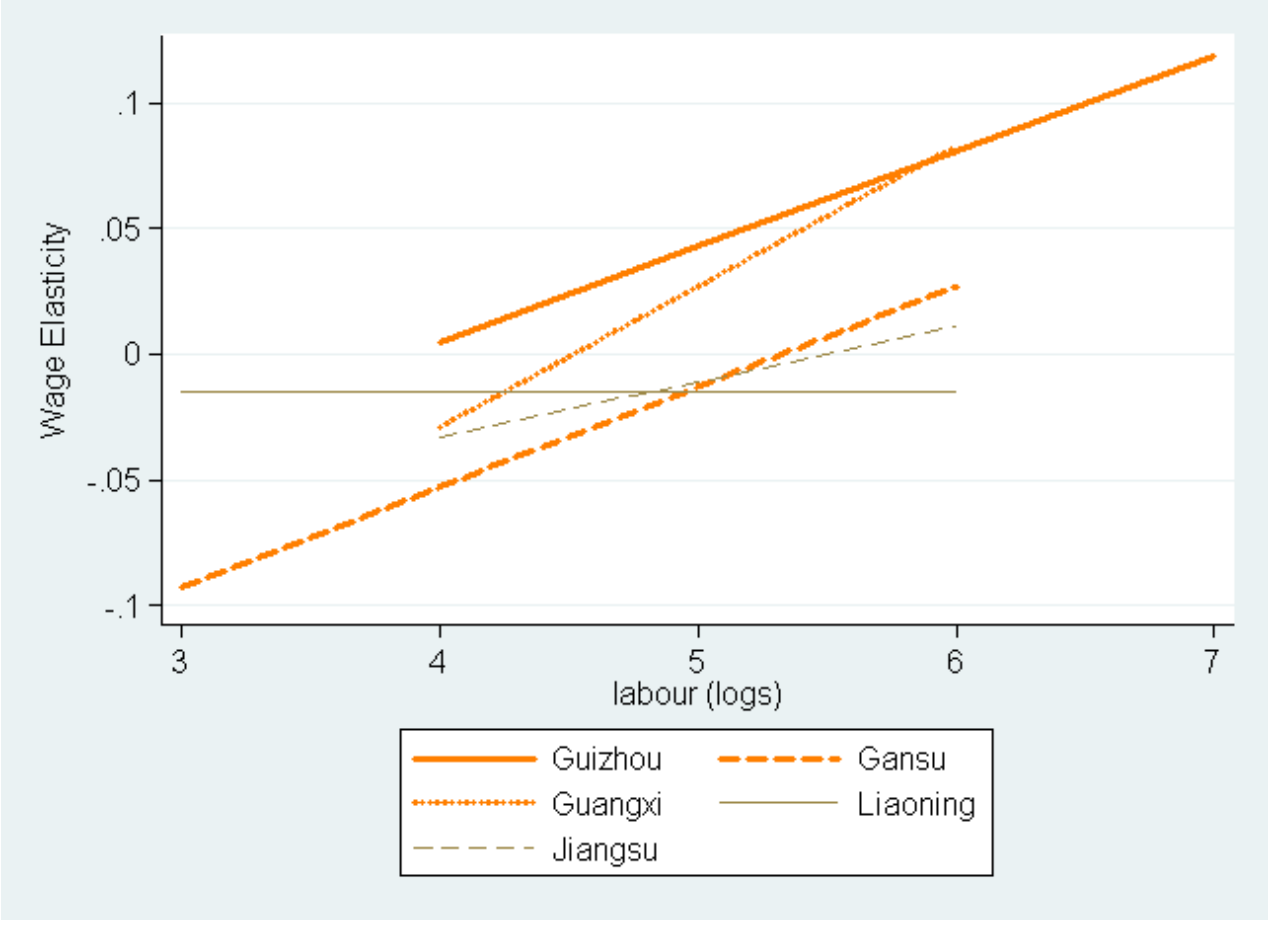
Wage cost regressions

	Guizhou	Gansu	Guangxi	Liaoning	Jiangsu
Labour (log)	-0.147	-0.213	-0.253	-0.015	-0.121
	[0.060]**	[0.070]***	[0.060]***	[0.027]	[0.012]***
Labour (log) ^ 2	0.019	0.020	0.028	0.000	0.011
	[0.006]***	[0.007]***	[0.006]***	[0.003]	[0.001]***
Highschool	0.043	0.018	0.097	0.033	-0.044
	[0.050]	[0.059]	[0.042]**	[0.022]	[0.010]***
University	0.425	0.523	0.753	0.463	0.693
	[0.081]***	[0.120]***	[0.078]***	[0.033]***	[0.023]***
Exporter	0.102	0.163	0.141	0.164	0.103
	[0.032]***	[0.060]***	[0.027]***	[0.012]***	[0.005]***
$\epsilon_{35.2}$ workers	-0.014	-0.069	-0.051	-0.014	-0.045
	[0.020]	[0.026]***	[0.021]**	[0.008]*	[0.004]***
$\epsilon_{81.4}$ workers	0.017	-0.035	-0.003	-0.014	-0.027
	[0.012]	[0.019]*	[0.013]	[0.006]**	[0.003]***
$\epsilon_{161.3}$ workers	0.042	-0.007	0.036	-0.014	-0.012
	[0.011]***	[0.016]	[0.010]***	[0.005]***	[0.002]***
$\epsilon_{769.4}$ workers	0.101	0.056	0.125	-0.014	0.021
	[0.024]***	[0.025]**	[0.021]***	[0.011]	[0.005]***
Obs	5,644	4,245	9,661	31,851	143,316
Firms	1,028	858	1,926	6,183	28,229
R^2	0.37	0.28	0.33	0.25	0.26

Notes: Regressions include sector, year, affiliation as well as ownership type dummies. Elasticities are computed for the mean firm size in each of the four size groups.

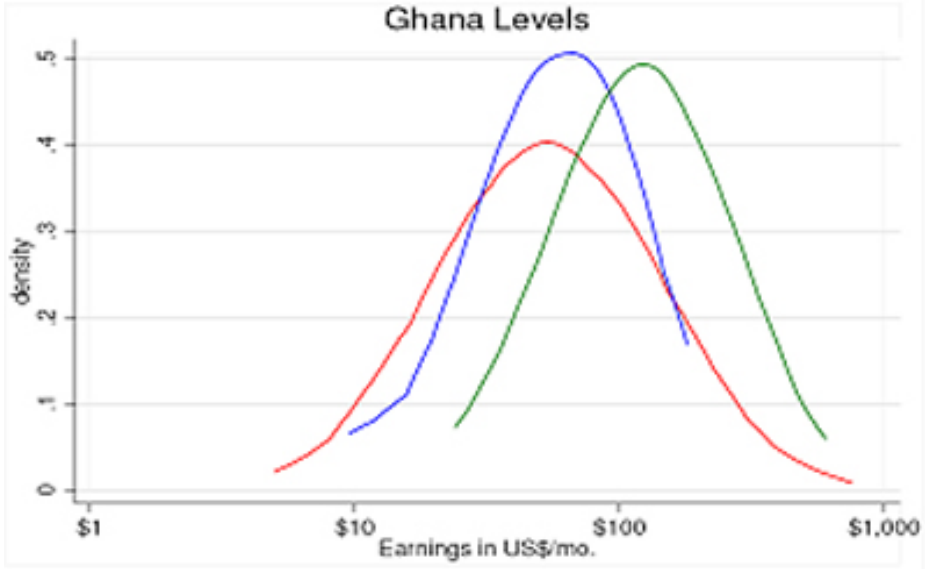
Wage cost elasticity wrt labour

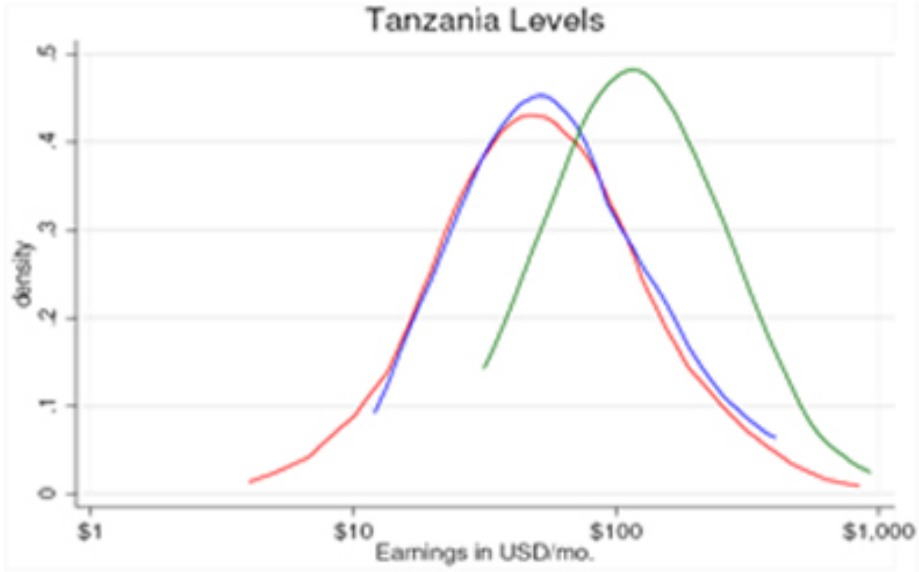
Derived from estimates in the above regression.



African wages and firm size

Taken from Sandefur and Teal (2006) — green = large





Summary

- **Reversal of the African IO (Descriptives)**
  - Smaller firms are more productive (Y/L, VA/L)...
  - ...especially in advanced provinces $\Rightarrow$ not due to SOEs!
  - K/L comparable btw larger/smaller firms, but M/L twice the magnitude in the latter.
  - Wage cost per worker uniform for advanced provinces, increased for larger firms in backward provinces.
- **Technology is nonhomothetic** — differs by factor inputs.
- Substantially larger **TFP level** dispersion in backward provinces, differences in TFP-levels and size.
- **Material coefficient** heterogeneity and change.
- **Capital intensity** relatively uniform across provinces, increasing in L.
- Much larger **wage elasticities with firm size** for poorer provinces.

Future work

- **More focused analysis**, try and get away from OLS.
- **Split paper** in two with focus on China and Lessons for Africa.

Thank you.

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University of Oxford

and

YU Zhihong
University of Nottingham

The University of Nottingham
UNITED KINGDOM · CHINA · MALAYSIA

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