Market structure, oligopsony power and productivity

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- Most attention devoted to product markets
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  - Input price mark*downs*
- How do changes in market structure affect both types of market power?

Empirical challenge

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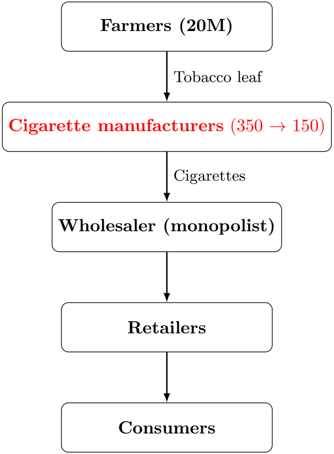
- This paper:
  - Setting: Chinese cigarette manufacturing
  - Downstream consolidation $\rightarrow$ product price *markups* & input price *markdowns*
  - Combine both approaches to identify markups + markdowns under general class of production models

Chinese tobacco industry



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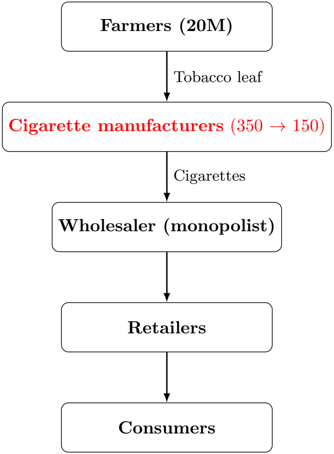
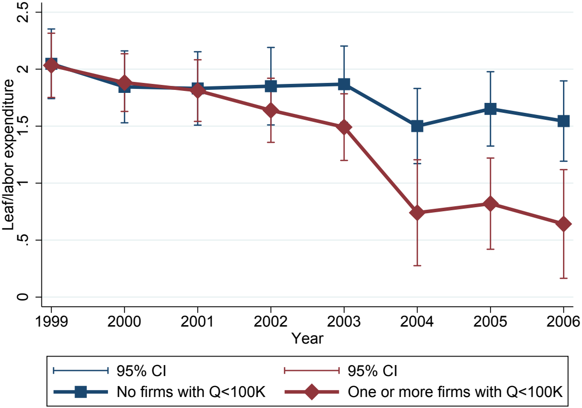


→ Data:

- NBS ASIF, firm-yr (N=2638)
- NBS quantity data: firm-product-yr

Input revenue shares

$$\frac{\text{Input expenditure}}{\text{Revenue}}$$



Cigarette production

$$Q_{ft} = \min\left\{\beta_{ft}^{M} M_{ft}, \Omega_{ft} H(L_{ft}, K_{ft})\right\} \exp(\varepsilon_{ft})$$

- Output Q, Leaf M, Labor L, Capital K
- Leaf content β^{M}, Productivity Ω, Measurement error ε

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Input supply

- Input prices W^L_{ft}, W^M_{ft}
- Manufacturing worker wages: exogenous
- Inverse leaf supply:

$$W^M_{ft} = W^M(M_{ft}, M_{-ft}, \mathbf{Z}_{ft}, \mathbf{Z}_{-ft}, \zeta_{ft}, \zeta_{-ft}) \quad \forall -f \in \mathcal{F}_{it}$$

- Leaf markets i, set of competitors $\mathcal{F}_{it}$
  - Baseline: prefecture-level markets
- Firm characteristics $\boldsymbol{Z}, \zeta$
- Price elasticity of supply $\psi^M_{ft} \equiv \frac{\partial W^M_{ft}}{\partial M_{ft}} \frac{M_{ft}}{W^M_{ft}} + 1$

firms per market

Tobacco farming

- Farmers: small plots, profitability $\downarrow$
- Isolated markets: regulated purchasing stations
- Crop substitution costly
- Exiting agriculture: Hukou system, land rights

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Manufacturer behavior

$$\max_{W_{ft}^M} \left(P_{ft}(\mathbf{W}_{it}^M)\beta_{ft}^M M(\mathbf{W}_{it}^M, \mathbf{Z}_{it}, \zeta_{it}) - W_{ft}^M M(\mathbf{W}_{it}^M, \mathbf{Z}_{it}, \zeta_{it}) - W_{ft}^L L_{ft} \right)$$
$$\forall f \in \mathcal{F}_{it}$$

- Static Nash-Bertrand game on the leaf market $\left(\sim \text{Berry(1994)}\right)$
- Profit maximization vs. cost minimization
  - What if they do not maximize profits?
- Exogenous product quality

Markups

$$\boxed{\mu_{ft} = \left(\frac{\alpha^L_{ft}}{\beta^L_{ft}} + \alpha^M_{ft} \psi^M_{ft} \right)^{-1}}$$

Notation: $\mu_{ft} \equiv \frac{P_{ft}}{\lambda_{ft}}$ $\alpha^V_{ft} \equiv \frac{V_{ft} W^V_{ft}}{P_{ft} Q_{ft}} \forall V \in (L, M)$ $\beta^L_{ft} \equiv \frac{\partial Q_{ft}}{\partial L_{ft}} \frac{L_{ft}}{Q_{ft}}$

derivation

Markups: comparison to prior approaches

$$\mu_{ft} = \left(\frac{\alpha^L_{ft}}{\beta^L_{ft}} + \alpha^M_{ft} \psi^M_{ft} \right)^{-1}$$

- $\psi^M = 1, \beta^M = 0 \Rightarrow \quad \mu = \frac{\beta^L}{\alpha^L}$ [De Loecker & Warzynski (2012)]
- $\psi^M = 1, \beta^M > 0 \Rightarrow \quad \mu = \left(\frac{\alpha^L}{\beta^L} + \alpha^M \right)^{-1}$ [De Loecker & Scott (2016)]
- $\psi^L > 1, \beta^M = 0 \Rightarrow \quad \mu = \frac{\beta^L}{\alpha^L \psi^L}$ [Morlacco (2019)]

Identification strategy

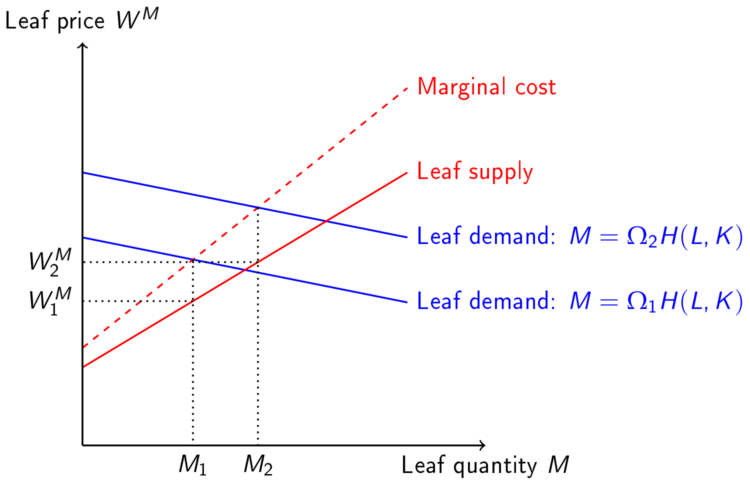
$$\mu_{ft} = \left(\frac{\alpha_{ft}^{L}}{\beta_{ft}^{L}} + \alpha_{ft}^{M} \psi_{ft}^{M} \right)^{-1}$$

- Identification: input supply models (ψ) + production function (β)
- Alternatives:
  - Product demand model (μ)+ production function: (β)
  - Product demand model (μ)+ input supply models: (ψ)

Identification

1. Production function
   - $Q = H(L, K)\Omega$
   - Timing assumptions (Ackerberg, Caves & Frazer, 2015)
2. Markups
   - $\mu \equiv \frac{P}{\lambda}$
   - Profit maximization assumption
3. Inverse leaf supply function
   - $W^M = W^M(M, \zeta, .)$
   - Input demand shifter: Ω

Identification of the leaf supply function

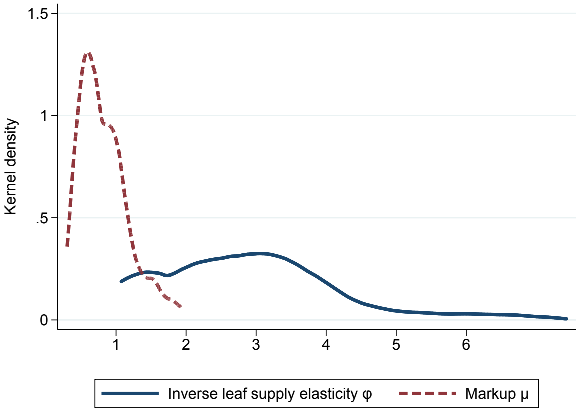


Estimation

$$\mu_{ft} = \left(\frac{\alpha_{ft}^{L}}{\beta_{ft}^{L}} + \alpha_{ft}^{M} \psi_{ft}^{M} \right)^{-1}$$

- β_{ft}^{L}: Cobb-Douglas production function (Implementation)
- ψ_{ft}^{M}: Leaf supply model (Implementation)
- Bootstrap entire procedure

Markups and markdowns



Substitutable inputs

Consolidation effects

- Denote $N_{it} = \sum_{f \in i}(\mathbb{I}[Q_{ft} < 100K])$ = firms forced to exit
- Size thresholds enforced in 2003
- Consolidation 'treatment': $C_f = \mathbb{I}[N_{i,2002} > 0]$
- Difference-in-differences regression:

$$y_{ft} = \theta_0^y + \theta_1^y \mathbb{I}[t \geq 2003] + \theta_2^y C_f \mathbb{I}[t \geq 2003] + \theta_3^y t + \theta_f^y + \upsilon_{ft}^y$$

with $y_{ft} \in \{\omega_{ft}, \ln(\psi_{ft}^M), \ln(\mu_{ft})\}$

Example with maps treatment & control group sizes

Consolidation effects: estimates

	log(Markdown)	log(Markup)	log(TFP)
Treatment * 1(year≥2003)	**0.314**	**-0.265**	0.075
	(0.065)	(0.065)	(0.082)
Observations	1,091	1,091	1,091
R-squared	0.811	0.764	0.867

Notes: Cobb-Douglas function in labor and capital. Controls: time trend, ownership types, product type, export dummy, firm fixed effects. Bootstrapped standard errors in parentheses. Treatment uses prefecture-level market definition.

Pre-trends Announcement effects Market definitions Different moments Heterogeneous effects Continuous treatment variable

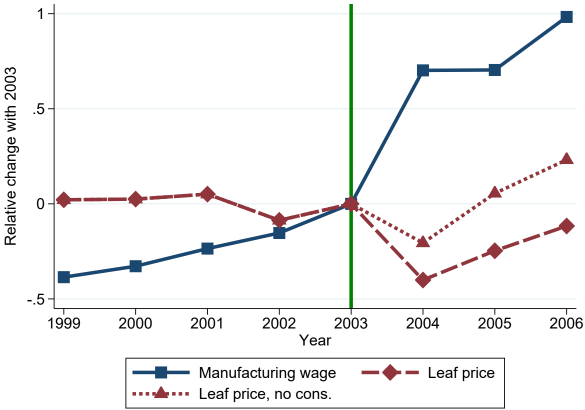
Distributional consequences

- Rural-urban inequality in China
  - Yang (1999), Ravallion & Chen (2009)
- Manufacturing workers vs. farmers
- Back-of-the-envelope calculation of $(\tilde{W}^M_{ft}, \tilde{P}_{ft})$:

$$\tilde{W}^M_{ft} = \begin{cases} W^M_{ft} \exp(\theta_2^{\psi^M}) & \text{if} \quad t \geq 2003 \quad \& \quad C_f = 1 \\ W^M_{ft} & \text{otherwise} \end{cases}$$

$$\tilde{P}_{ft} = \begin{cases} P_{ft} \exp(\theta_2^{\mu}) & \text{if} \quad t \geq 2003 \quad \& \quad C_f = 1 \\ P_{ft} & \text{otherwise} \end{cases}$$

Farm income vs. manufacturing wage growth



Different market definitions

Productive efficiency

- Productivity gains from mergers (Braguinsky et al., 2015; Grieco, Pinkse & Slade, 2017) and SOE privatization: (Hsieh & Song, 2015)
- But, TFP interpretation with endogenous input price:

$$q_{ft} = \beta^L l_{ft} + \beta^K k_{ft} + \beta^M (m_{ft} + w_{ft}^M) + \omega_{ft}$$

Model	log(TFP) Leontief	log(TFP) C-D
Treatment * 1(year≥2003)	0.075	0.266
	(0.082)	(0.079)
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Scale economies & fixed costs

Extensions

- Substitutability of tobacco leaf
- Labor-augmenting productivity
- Nested logit supply model
- Heterogeneous product characteristics
- Translog production function

Conclusions

- Effects of downstream consolidation
  - Increased market power on rural input markets
  - Effects propagated through value chain, markups fell
  - Large distributional consequences

Conclusions

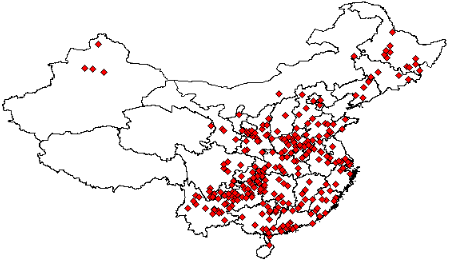
- Effects of downstream consolidation
  - Increased market power on rural input markets
  - Effects propagated through value chain, markups fell
  - Large distributional consequences
- Identifying markups from markdowns
  - Input supply + production model, no product demand model
  - Other combinations possible, depends on research question & industry
  - Markup/markdown identification with non-substitutable inputs

Looking ahead

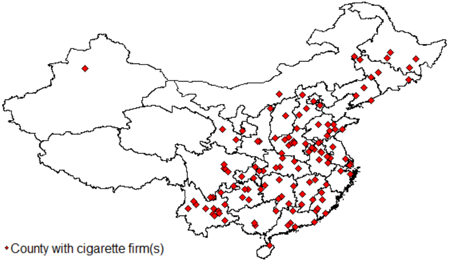
- This paper: non-substitutable inputs
- What if firms can substitute between inputs?
- Incentive to adopt factor-biased technologies depends on monopsony power
- Can identify markdowns from factor-augmenting productivity by adding supply model

Production locations

1999:



2006:



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Additional data

- 2000 Population census (county level)
- Brand-level product characteristics: (N=383)

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Ownership consolidation

- Consolidation was centrally planned
- May 2, 2002 statement by the *State Tobacco Monopoly Administration*:
  - *"The problem of scattering in the organizational structure of enterprises is still very serious"*
  - *"For enterprises with an output of less than 100K cases [...] bankruptcies and reemployment programs will be implemented"*
  - *"**Increasing** the **concentration** of cigarette production and increasing the **economies of scale** of the tobacco industry."*

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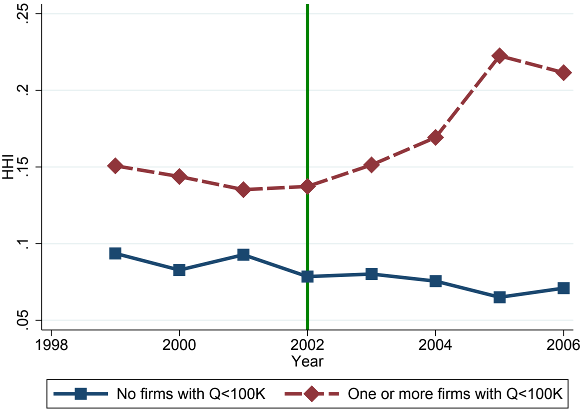
First stage



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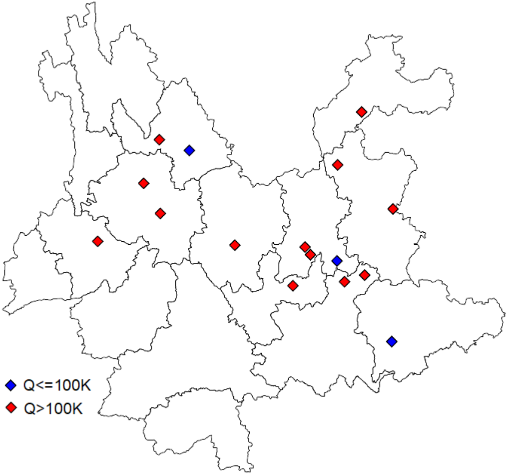
Example: Yunnan province



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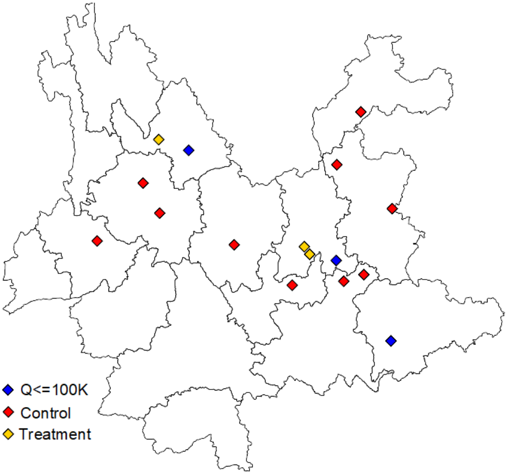

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Consolidation in other Chinese industries

- 2003: creation of *SASAC*: energy, telecom, steel (and much more)
- Recent ‘mega-mergers’:
  - Railroads (CNR & CSR, 2015)
  - Logistics & transportation (Sinotrans - CMG, 2015)
  - Raw materials: (CNCR-Sinograin, cotton, 2017)
  - Seaports: consolidate into provincial firms: Zhejiang (2015), other provinces (2016-current.)

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Number of manufacturers per input market

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Province

# Firms	Mean	Std. Dev.
1	0.05	0.19
2	0.02	0.15
3	0.03	0.17
4	0.04	0.21
> 4	0.86	0.34
N	2638	

Prefecture

# Firms	Mean	Std. Dev.
1	0.27	0.45
2	0.25	0.43
3	0.20	0.40
4	0.15	0.35
> 4	0.09	0.28
N	2638	

County

# Firms	Mean	Std. Dev.
1	0.65	0.48
2	0.25	0.43
3	0.08	0.26
4	0.02	0.13
> 4	0.01	0.08
N	2638	

Treatment & control group sizes

back

	% of firms	% of revenue
Firms producing less than 100K cases	50.4	8.1
Treatment* (province-level)	86.1	89.2
Treatment (prefecture-level)	38.8	38.3
Treatment (county-level)	14.9	11.7

Note: *Firms with competitors producing less than 100K cases in same county/prefecture/province

Heterogeneous effects

back

	log(Markdown)			
(.)*# firms under 100K	**1.379**			
	(0.607)			
(.)*log(output)		**-0.364**		
		(0.096)		
(.)*log(unemployment rate)			**0.457**	
			(0.215)	
(.)*log(immigrant share)				**0.832**
				(0.268)
Treatment * I(year≥2003)	-0.808	4.925	2.326	3.948
	(0.756)	(1.134)	(0.813)	(1.017)
Observations	779	771	779	771
R-squared	0.338	0.470	0.336	0.327

Comparison to literature

Paper	Industry	Input	Input price / MRP
Goolsbee & Syverson (2019)	Universities	Professors	0.83
Ransom & Sims (2010)	Schools	Teachers	0.75-0.82
Hirsch et al. (2010)	All	Employees	0.78
Ransom & Oaxaca (2010)	Grocery stores	Clerks	0.70 - 0.74
Morlacco (2019)	French mfg	Materials	0.61
This paper	Cigarettes	Tob. leaf	0.43

Note: I report the average price of an input over its marginal revenue product, which I calculate based on the reported labor supply elasticity.

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Overidentifying restrictions

Dep. var.: log(leaf m.share) - log(outside option m.share)		
Instruments:	TFP	TFP & consolidation treatment
Leaf price	3.671	3.659
	(0.862)	(1.793)
Observations	1,091	1,091
1st stage F-stat	418.5	87.97
Sargan χ^2		4.332
Sargan test p-value		0.115
R-squared	0.053	0.147

Notes: Controls: export dummy and share of revenue, cigarette price,
time trend, product type, prefecture dummy, ownership type. Market shares at province-level.
Instrument: TFP (column 1), TFP and consolidation treatment dummies at both province and county

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Distributional consequences

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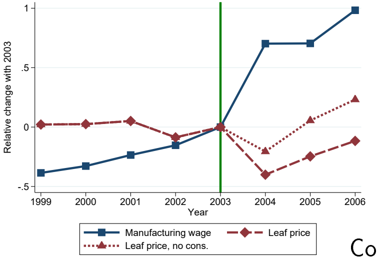
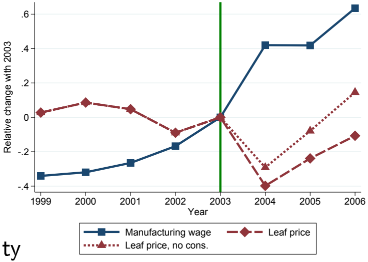
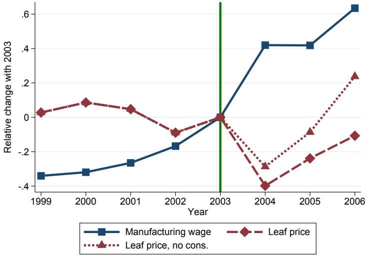
Province



Prefecture



County



Scale economies

- Other scale economies: duplicated fixed costs, distributions costs, ...

$$FC_{ft} = P_{ft}Q_{ft} - M_{ft}W^M_{ft} - L_{ft}W^L_{ft} - \Pi_{ft}$$

Dependent variable:	log(FC)	log(Capital)
Treatment * 1(year≥2003)	0.269	0.043
	(0.241)	(0.192)
Observations	743	763
R-squared	0.154	0.079
Level	Prefect.-yr	Prefect.-yr

back

Leaf supply model

- Farmer j sells to cigarette manufacturer $f \in \mathcal{F}_{it}$ in market i
- Outside option: $f = 0$ with zero mean utility
- $U_{jft} = \gamma^W W_{ft}^M + \gamma^Z \mathbf{Z}_{ft} + \zeta_{ft} + \nu_{jft}$
- Denote leaf market share as $S_{ft} = \frac{M_{ft}}{\sum_{r \in \mathcal{F}_{it}} M_{frt}}$

Assumption

The preference shocks ν_{jft} follow a type-I extreme value distribution

$$S_{ft} = \frac{\exp(\gamma^W W_{ft}^M + \gamma^Z \mathbf{Z}_{ft} + \zeta_{ft})}{\sum_{r \in \mathcal{F}_{it}} \exp(\gamma^W W_{rt}^M + \gamma^Z \mathbf{Z}_{rt} + \zeta_{rt})}$$

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Leaf supply: estimation

$$\log(S_{ft}) - \log(S_{0t}) = \gamma^W W_{ft}^M + \gamma^Z \mathbf{Z}_{ft} + \zeta_{ft} - \zeta_{0t}$$

- Need instrument for W_{ft}^M due to ζ_{ft}
- Use productivity shocks $\hat{\omega}_{ft}$ as instrument
  - Assumption: ω_{ft} does not enter $U(.)$
  - Violation examples
  - Can use consolidation treatment as IV $\rightarrow$ overid. restrictions
- Markdown:

$$\psi_{ft}^M = \left(\gamma^M W_{ft}^M (1 - S_{ft})\right)^{-1}$$

Leaf supply: estimates

	log(Leaf ms*)		log(Labor ms*)	
	OLS	IV	OLS	IV
Input price	-0.172	3.671	-0.0001	-0.029
	(0.097)	(0.862)	(0.001)	(0.068)
R-squared	0.863	0.119	0.904	0.793
1st stage F-statistic	–	79.14	–	21.89
Observations	1,091	1,091	1,091	1,091

Notes: *log(Input market share) - log(Outside option market share. Province-level markets. RHS: leaf price per pack in 1000 RMB & wage per employee/year in 1000 RMB. Controls: prefecture dummies, ownership dummies, and cigarette prices, unit wages.

comparison with literature | overidentifying restrictions | back

Production model

$$q_{ft} = h(l_{ft}, k_{ft}) + \omega_{ft}$$
$$\omega_{ft} = g(\omega_{ft-1}, C_{ft}), \quad C_{ft} \in \{0, 1\}$$

- Baseline: Cobb-Douglas

$$h(L_{ft}, K_{ft}) = \beta^L l_{ft} + \beta^K k_{ft}$$

- Alternative: Translog

$$h(L_{ft}, K_{ft}) = \beta^L l_{ft} + \beta^K k_{ft} + \beta^{LK} l_{ft} k_{ft} + \beta^{2L} l_{ft}^2 + 2\beta^{2K} k_{ft}^2$$

Production function: estimation

- Use ACF(2015)
- Challenges:
- Product & input differentiation
  - De Loecker et al. (2016): $q_{ft} = \tilde{h}(l_{ft}, k_{ft}) + A(w^L_{ft}, p_{ft}) + \omega_{ft}$
- Latent markdowns & TFP inversion
  - Control for input market shares & prices in 1st stage details
- Technology heterogeneity: cfr. extension

Production function: moment conditions

- Cobb-Douglas:

$$\mathbb{E}\left\{\xi_{ft}(\beta^l, \beta^k)\begin{pmatrix} l_{ft-1} \\ k_{ft} \end{pmatrix}\right\} = 0$$

- Translog:

$$\mathbb{E}\left\{\xi_{ft}(\beta^L, \beta^K, \beta^{LK}, \beta^{L2}, \beta^{K2})\begin{pmatrix} l_{ft-1} \\ k_{ft} \\ l_{ft-1}k_{ft} \\ l^2_{ft-1} \\ k^2_{ft} \end{pmatrix}\right\} = 0$$

Production function: results

	log(Output)	
log(Labor)	0.320	0.404
	(0.226)	(0.096)
log(Capital)	0.761	0.699
	(0.140)	(0.107)
Returns to scale	1.081	1.104
	(0.191)	(0.079)
Observations	823	1,108
Method	ACF	IV
R-squared	0.989	0.887

Notes: Bootstrapped standard errors in parentheses

back to main slides

Production function: non-iid input prices

- Leaf demand: $M_{ft} = \frac{\Omega_{ft}}{\beta^M} H(L_{ft}, K_{ft})$
- Labor demand?
  - $l_{ft} = l(\boldsymbol{\beta}, \mathbf{w}, k, p, \psi^M_{ft}, \omega_{ft})$
  - In order to invert ω, need to control for ψ^M.
  - Logit supply model $\rightarrow$ suffices to include S_{ft}, W^M_{ft}
  - Include consolidation C_{ft} due to TFP law of motion
- Inversion of ω from input demand?
- First stage: derivation

$$q_{ft} = \Phi(l_{ft}, k_{ft}, \mathbf{w_{ft}}, c_{ft}, p_{ft}, s_{ft}) + \varepsilon_{ft}$$

- Use third-order polynomial in l and k, linear in other variables

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Substitutability of tobacco leaf

$$Q_{ft} = \left(\left(\beta^M M_{ft}^{\frac{\sigma^M - 1}{\sigma^M}} + \beta^L L_{ft}^{\frac{\sigma^M - 1}{\sigma^M}} \right)^{\frac{\sigma^M}{\sigma^M - 1}} \right)^{\beta^{ML}} K_{ft}^{\beta^K} \Omega_{ft}$$

$$l_{ft} - m_{ft} = \sigma^M \big(\ln(W_{ft}^M) - \ln(W_{ft}^L) \big) - \sigma^M \big(\ln(\beta^M) - \ln(\beta^L) \big) + \sigma^M \ln(1 + \psi_{ft}^M)$$

Substitutability of tobacco leaf

	log(Materials/Labor)	log(Capital/Labor)
log(Labor wage)	0.146	0.909
	(0.281)	(0.222)
Observations	1,091	1,091
R-squared	0.283	0.478
1st stage F-stat	64.58	64.58

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Factor-augmenting productivity

- Doraszelski (2017) with endogenous input prices:

$$H(L_{ft}, K_{ft}) = \left(\beta^K K_{ft}^{\frac{\sigma^K - 1}{\sigma^K}} + \beta^L (L_{ft}\Omega^L_f)^{\frac{\sigma^K - 1}{\sigma^K}}\right)^{\frac{\sigma^K}{\sigma^K - 1}} \exp(\omega_{ft})$$

$$k_{ft} - l_{ft} = \sigma^K \left(\ln(W^L_{ft}) - \ln(W^K_{ft})\right) + \sigma^K \left(\ln(\beta^K) - \ln(\beta^L)\right) + (1 - \sigma^K)(\omega^L_{ft})$$

$$\mu_{ft} = \left(\frac{\alpha^L_{ft}}{\beta^L_{ft}\Omega^L_{ft}}\psi^L_{ft} + \alpha^M_{ft}\psi^M_{ft}\right)^{-1}$$

Factor-augmenting productivity

	log(LAP*)
Treatment * 1(year≥2003)	0.228
	(0.089)
Observations	1,091
R-squared	0.662

Notes: *Labor-augmenting productivity. Dependent variables in logs. Markup re-calculated with labor-augmenting productivity taken into account.

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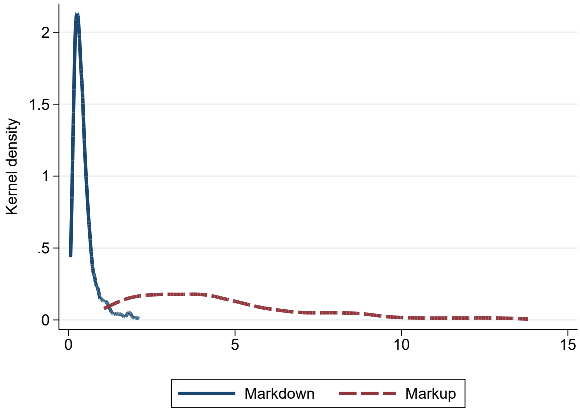
Substitutable inputs model



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Translog PF: output elasticities, markdowns and markups

	Labor	Capital
Output elasticity	0.353	0.690
	(0.226)	(0.140)

	Markdown	Markup
Mean	2.428	1.143
	(1.280)	(0.230)

Translog PF: treatment effects

	log(Markdown)	log(Markup)	log(TFP)
Treatment *1(year≥2003)	0.291	-0.247	0.078
	(0.061)	(0.061)	(0.083)
R-squared	0.799	0.751	0.866
Observations	1,091	1,091	1,091

Back

Nested logit

- Manufacturers now grouped into nests g
- Farmers j choose $f \in \mathcal{F}_{it}^{g}$, elasticity σ

$$U_{jft} = \underbrace{\gamma^W W_{ft}^M + \gamma^Z \mathbf{Z}_{ft} + \zeta_{jt}}_{\delta_{ft}} + (1-\sigma)\nu_{jft}$$

- Input market share:

$$S_{ft} = \frac{\exp(\frac{\delta_{ft}}{1-\sigma})}{D_{gt}^{\sigma}[\sum_g D_{gt}^{1-\sigma}]} \text{ with } D_{gt} \equiv \sum_{f \in \mathcal{F}_{it}^{g}} \exp(\frac{\delta_{ft}}{1-\sigma})$$

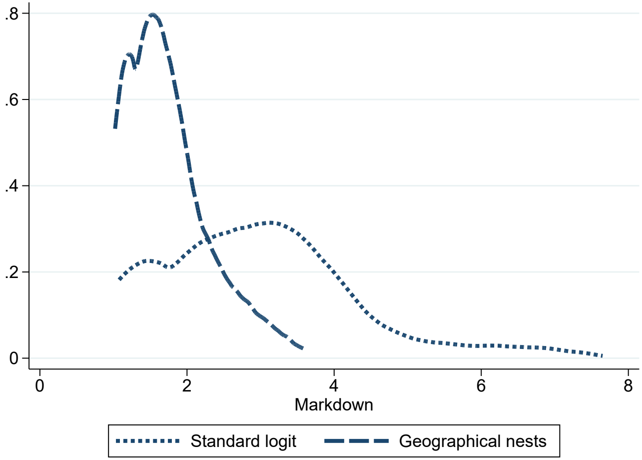
- Markdown:

$$\psi_{ft}^M = \left(\gamma^W W_{ft}^M \left(\frac{1}{1-\sigma} - \frac{\sigma}{1-\sigma} S_{fgt} - S_{ft}\right)\right)^{-1} + 1$$

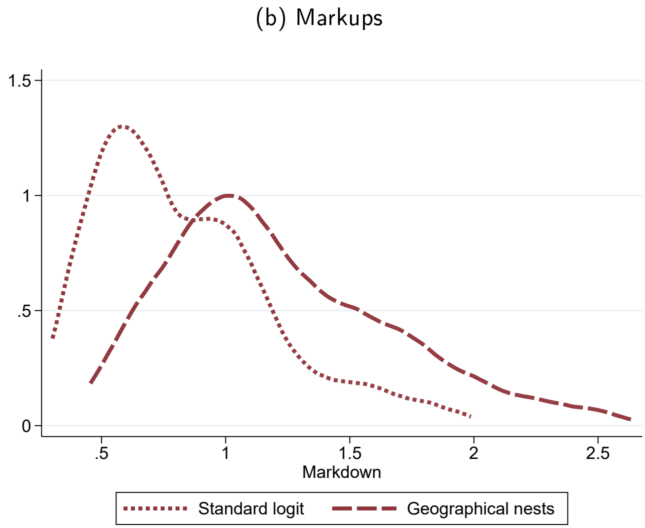
- Nests: ownership types, counties within prefectures

Nested logit

(a) Markdowns



Nested logit



Heterogeneous product characteristics

Treatment vs. control group

	Leaf mass	Filter dens.	Rod dens.	Paper	Ventilation
Treatment	0.00468	-0.00215	-0.000249	-0.0107	-1.423
	(0.00299)	(0.00371)	(0.00585)	(0.0225)	(0.494)
Observations	189	189	189	189	189
R-squared	0.842	0.703	0.515	0.561	0.777
Unit	mg	mg/ml	mg/ml	CORESTA*	%

Back to extensions

Correlations with markups, markdowns, TFP additional data

Heterogeneous product characteristics

Correlations with markups, markdowns and productivity

	log(Markup)	log(Markdown)	log(TFP)	log(Leaf price)
Ventilation	0.0149	0.0261	-0.00883	-0.00520
	(0.0281)	(0.0303)	(0.0573)	(0.0631)
Rod density	4.685	-0.253	1.224	0.0983
	(6.984)	(7.524)	(14.24)	(15.67)
Filter density	22.46	-8.990	-9.010	4.338
	(6.346)	(6.836)	(12.93)	(14.24)
Leaf weight	11.66	-5.984	-9.399	-6.184
	(3.651)	(3.933)	(7.441)	(8.193)
Paper permeability	1.981	-1.391	-0.786	2.931
	(1.355)	(1.459)	(2.761)	(3.040)
Observations	137	137	137	137
R-squared	0.687	0.700	0.488	0.501

Standard errors in parentheses
Estimated pre-treatment period, 1999-2002
Controls: province dummies

Back to extensions

Pre-trends

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	log(Markdown)	log(Markup)	log(TFP)
Treatment*Year	0.089	-0.077	-0.054
	(0.084)	(0.093)	(0.042)
Year	-0.046	0.095	0.042
	(0.082)	(0.090)	(0.030)
R-squared	0.316	0.095	0.404
Observations	756	756	756

Announcement effects

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	log(Markdown)	log(Markup)	log(TFP)
Treatment * 1(year≥2000)	0.011	-0.161	-0.081
	(0.083)	(0.064)	(0.065)
Treatment * 1(year≥2001))	0.164	-0.008	-0.065
	(0.046)	(0.055)	(0.089)
Treatment * 1(year≥2002)	0.144	-0.128	0.067
	(0.057)	(0.060)	(0.106)

Notes: I re-estimate the difference-in-differences model from equation (17). In contrast with the main specification, I define the start of the treatment effect to take place in 2000, 2001 and 2002 in panels (a), (b) and (c). The specific size thresholds were announced in 2002.

Other market definitions

	log(Markdown)	log(Markup)	log(TFP)
Province	0.299	-0.255	0.074
	(0.063)	(0.064)	(0.082)
Prefecture	0.405	-0.245	0.107
	(0.071)	(0.074)	(0.069)
County	0.788	-0.413	0.084
	(0.134)	(0.111)	(0.103)

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Alternative treatment measures

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	log(Markdown)	log(Markup)	log(TFP)
(a) Share of firms			
Treatment * 1(year≥2003)	0.795	-0.349	0.353
	(0.144)	(0.154)	(0.203)
(b) Employment share treated			
Treatment * 1(year≥2003)	0.270	-0.353	0.482
	(0.261)	(0.272)	(0.291)

Different moments

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	log(Markdown)	log(Markup)	log(TFP)
(a) Median			
Treatment * 1(year≥2003)	0.149	-0.140	-0.033
	(0.022)	(0.051)	(0.052)
(b) L-weighted avg.			
Treatment * 1(year≥2003)	0.296	-0.240	-0.057
	(0.064)	(0.068)	(0.106)

Markups - derivation

$$\text{Marginal cost: } \lambda_{ft} = \frac{\partial(W^L_{ft} L_{ft})}{\partial Q_{ft}} + \frac{\partial(M_{ft} W^M_{ft})}{\partial Q_{ft}}$$

$$= \frac{W_{ft} L_{ft}}{Q_{ft}\beta^L} + \frac{\partial(W^M_{ft})}{\partial Q_{ft}} M_{ft} + W^M_{ft} \frac{\partial(\frac{Q_{ft}}{\Omega^M_{ft}})}{\partial Q_{ft}}$$

$$= \frac{W^L_{ft} L_{ft}}{Q_{ft}\beta^L} + \frac{W^M_{ft}}{\Omega^M_{ft}} \Big(\frac{\partial W^M_{ft}}{\partial Q_{ft}} \frac{Q_{ft}}{W^M_{ft}} + 1 \Big)$$

$$\text{Markup: } \mu_{ft} \equiv \frac{P_{ft}}{\lambda_{ft}} = \frac{1}{(\mu^L_{ft})^{-1} + \alpha^M_{ft}\psi_{ft}}$$

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Labor demand: derivation

$$\min_{L_{ft}} \Big(W^L_{ft} L_{ft} + W^M_{ft} M_{ft} - \lambda_{ft} \big(Q(L_{ft}, M_{ft}, K_{ft}, \Omega_{ft}, \beta^M_{ft}) - Q_{ft} \big) \Big)$$

$$\Rightarrow W^L_{ft} + \frac{\partial W^M_{ft}}{\partial M_{ft}} \frac{\partial M_{ft}}{\partial Q_{ft}} \frac{\partial Q_{ft}}{\partial L_{ft}} M_{ft} + W^M_{ft} \frac{\partial M_{ft}}{\partial Q_{ft}} \frac{\partial Q_{ft}}{\partial L_{ft}} - \lambda_{ft} \frac{\partial Q_{ft}}{\partial L_{ft}} = 0$$

Assuming $H_{ft}(L_{ft}, K_{ft}) = L_{ft}^{\beta_L} K_{ft}^{\beta_K}$:

$$\Rightarrow L_{ft} = \left(\frac{\left(\frac{P_{ft}}{\mu_{ft}} - \frac{W^M_{ft}\psi_{ft}}{\beta^M_{ft}}\right) \beta^L K_{ft}^{\beta^K} \Omega_{ft}}{W^L_{ft}} \right)^{\frac{1}{1-\beta^L}}$$

$$\Leftrightarrow l_{ft} = \Big(\frac{1}{1-\beta^L} \Big) \Big(\log \big(\frac{P_{ft}}{\mu_{ft}} - \frac{W^M_{ft}\psi_{ft}}{\beta^M_{ft}} \big) + \omega_{ft} - w^L_{ft} + \beta^K k_{ft} \Big)$$

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