Local Corporate Taxes and the Geography of Foreign Multinationals

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Motivation

- Many developing countries impose low corporate taxes on foreign multinationals
  - Ambitious goals: fostering regional development, generating positive spillovers, reducing regional inequality
  - Lack of coordination: regional competition and zoning policies make tax gaps vary considerably within the host country
  - The economic impact is not yet clear
- Questions
  - How does regional dispersion of corporate tax gaps between domestic and foreign firms shape the geography of production and welfare?
  - What is the impact of local tax competition, what are the optimal corporate taxes?
- Challenges
  - The effective local corporate tax rates are endogenous
  - Need a quantifiable model to answer welfare & CF questions

This Paper

#1 Identify the impacts of effective local corporate tax rates on regional production in the context of China by exploiting China's 2008 corporate tax reform

- Estimating the impact of changes in net-of-tax rates on regional output

#2 Develops a spatial GE model with MP and local corporate taxes

- Recover the key model parameter, the elasticity of multi-site production w.r.t. variable cost, guided by the model and empirical estimation
- Quantify the welfare implications of the corporate tax changes in various scenarios: the 2008 Tax Reform, Nash, Optimal

Preview of Results

- Model-consistent estimation suggests that firm productions *across regions* within China are twice as "footloose" as they are *across countries* (cf. Arkolakis et al. (2018) and Wang (2020))

- China's corporate tax reform in 2008
  - shifted foreign MP towards central and western provinces (consistent with the data)
  - increased Chinese welfare by 0.80% and reduced income inequality across provinces

- Regional tax competition within China
  - *beggar-thy-neighbour* policy: low/negative corporate taxes in the Nash equilibrium
  - Chinese welfare reduces by 5.57% (by 2.04% without foreign MP)

- Optimal corporate taxes
  - almost uniformly high corporate taxes on foreign but low taxes on domestic firms
  - Chinese welfare increases by 3.28% (by 0.08% without foreign MP)

Related Literature

- Multinationals and international trade
  - Ramondo (2014), Irarrazabal et al. (2013), Tintelnot (2017), Arkolakis et al. (2018), Garetto et al. (2019), Wang (2020), Setzler & Tintelnot (2021)
  - This paper: first *quantitative* exploration of the implications of foreign multinationals for regional policy competition and coordination *within the host country*.

- Quantitative spatial models
  - Redding (2016), Ramondo et al. (2016), and Caliendo et al. (2018)
  - This paper: incorporate into our framework the Chinese corporate tax structure and allow for multi-site production

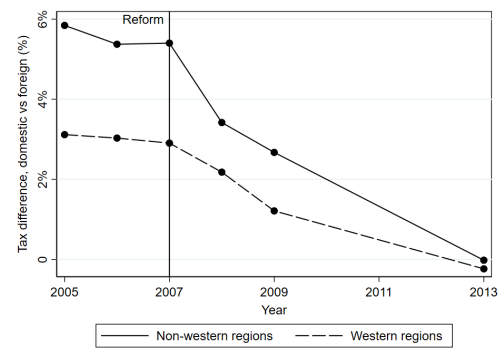
- Corporate taxes and the spatial allocation of firms
  - Fajgelbaum et al. (2019), Ossa (2015), Suarez Serrato and Zidar (2016), Henkel et al. (2021) and Mast (2020)
  - This paper: focuses on the implications of MNEs and uses the 2008 tax reform to assist in model identification and validation

China's corporate tax system and the 2008 reform

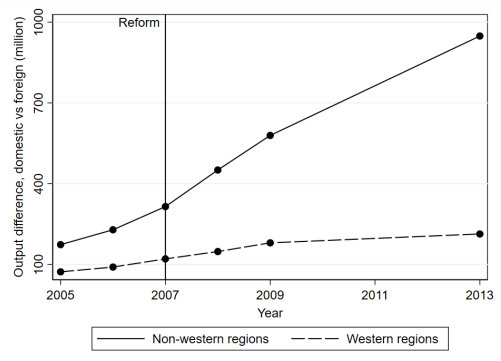
- Prior to 2007: relatively stable dual-track corporate tax system
  - Statutory tax rates: 33% for domestic-owned enterprises, 15% to 24% to MNEs
  - The effective tax rates of domestic firms were 70% higher on average
  - One exception: western provinces due to the China's Western Development Program, which set statutory tax at 15% for all firms

- China's corporate tax reform in Jan 2008
  - Phased-in reform, 2008-2013
  - Integrated the statutory tax rate of both domestic and foreign firms to 25%
  - The West Development program continued to operate until 2020

Suggestive Evidence



Effective corporate tax rates gaps between domestic and foreign firms



Output differences between domestic and foreign firms

Effective Corporate Tax Rates on Regional Production

- Model-consistent specification:

$$\log X_{j\ell t} = \beta \qquad \log\left(1 - \tilde{\kappa}_{j\ell t}\right) + D_{j\ell} + D_{\ell t} + D_{jt} + \epsilon_{j\ell t}, \tag{1}$$

  - $X_{j\ell t}$: total revenue of type $j \in \{Foreign, Domestic\}$ firms in region ℓ in year t
  - $\tilde{\kappa}_{j\ell t}$: average effective corporate tax rates of Home/Foreign firms located in the region ℓ in year t

- Instrument net-of-tax rate $\log\left(1 - \tilde{\kappa}_{j\ell t}\right)$ with $Foreign \times West \times Post07$

- Validity of the IV:
  - China's corporate tax reform in 2008 is a universal treatment for all regions
  - The low corporate tax rate in China's western provinces was established by the central government as part of a broad western development strategy in 2001
  - Any confounding factor that biases the IV estimate has to be specific to foreign multinationals in the western provinces of China after 2007

Effective Corporate Tax Rates on Regional Production

- Model-consistent specification:

$$\log X_{j\ell t} = \underbrace{\beta^{IV}}_{\textbf{12.31 (5.41)}} \log\left(1-\tilde{\kappa}_{j\ell t}\right) + D_{j\ell} + D_{\ell t} + D_{jt} + \epsilon_{j\ell t}, \tag{1}$$

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Empirical Details

A Spatial Model with MP and Local Corporate Taxes

- N home regions indexed by $i = 1, \ldots, N$ and one foreign region indexed by $i = 0$
- Labor is *mobile* across home regions but *immobile* across countries. Consumer values Utility fun.

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- Home and foreign firms with masses $\left\{ M_{j=H/F} \right\}$ engage in monopolistic competition

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  - local amenity levels draw from Fréchet (A_i, η) and migration friction d_{oi}
- Home and foreign firms with masses $\left\{M_{j=H/F}\right\}$ engage in monopolistic competition
  - The core productivity $\varphi_j(\omega)$ draws from Pareto (T_j, θ)
  - The vector of production-site-specific productivity $\{z_{j\ell}(\omega)\}_{\ell=0}^{N}$ is drawn independently across firms from a multivariate Fréchet

$$\Pr\left[z_{j0}(\omega) \leq z_0, \ldots, z_{jN}(\omega) \leq z_N\right] = \exp\left\{-\left(\sum_{\ell=1}^{N}\left[B_\ell z_\ell^{-\epsilon}\right]^{\frac{1}{1-\rho}}\right)^{1-\rho} - B_0 z_0^{-\epsilon}\right\}$$

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multi-site elasticity $= \frac{\epsilon}{1-\rho}$

A Spatial Model with MP and Local Corporate Taxes

- Regions/countries are connected via trade and multi-site production
  - The unit cost for firm ω with type j producing in region ℓ:

$$c_{j\ell}(\omega) = \frac{w_\ell \gamma_{j\ell}}{\varphi_j(\omega) z_{j\ell}(\omega) L_\ell}^{\alpha}$$

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iceberg MP cost

≥ 0, agglomeration force

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  - The unit cost for firm ω with type j to produce in region ℓ and sell to region n:

$$c_{j\ell n}(\omega) = c_{j\ell}(\omega) \tau_{\ell n}^{j}$$

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Equiv. to an cost shifter $\kappa_{j\ell} = (1 - \tilde{\kappa}_{j\ell})^{\frac{1}{1-\sigma}}$

A Spatial Model with MP and Local Corporate Taxes

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  - To sell to region n, firms pay a fixed cost F_n in terms of labor (not deductible)
  - Firm with type j producing in region ℓ faces corporate taxes with the rate $\tilde{\kappa}_{j\ell}$
- Tax and profits distribution
  - Firms' headquarter countries obtain the post-tax profits, which are distributed across Home regions proportional to # firms
  - Tax revenue from each region of China: 40% is distributed equally to local workers and 60% to workers in other parts of the country

Equilibrium and Calibration

- Calibrate the model in relative changes to perform counterfactuals
  - Have guidance on most model parameters, except for ρ ($\frac{\epsilon}{1-\rho}$ informs how sensitive production is across regions within a country when local variable cost changes)
  - The model predicts:

$$\log X_{j\ell} = \frac{\frac{\epsilon}{1-\rho} - (\sigma - 1)}{\sigma - 1} \log(1 - \tilde{\kappa}_{j\ell}) + D_\ell + D_j + u_{j\ell} \tag{2}$$

  - The IV estimate suggest $\frac{\frac{\epsilon}{1-\rho} - (\sigma-1)}{\sigma-1} = 12.31$. Calibrate $\sigma = 2.94$ (Deng and Wang 2021) we then obtain $\frac{\epsilon}{1-\rho} = 25.82$
  - This elasticity is much larger than that across countries: the estimate is 10.9 in Arkolakis et al. (2018) and 7.69 in Wang (2020)

Counterfactual #1: China's Corporate Tax Reform

- Counterfactual: starting from the economy in 2007, we change the effective corporate taxes in each province, $(\tilde{\kappa}_{j\ell})_{\ell=1}^{N}$, to their 2013 levels.

Table: The Effects of the Tax Reform: Illustrative Examples

	Shanghai Domestic (1)	Shanghai Foreign (2)	Chongqing Domestic (3)	Chongqing Foreign (4)
Tax rate before reform	14.18	7.31	9.93	6.69
Tax rate after reform	13.67	13.21	8.33	6.89
Changes %	-3.57	80.62	-16.17	2.99
Local output of foreign firms	-1.28	-18.22	-10.05	-1.32
Local output of domestic firms	1.62	13.59	3.09	0.34
Local tax revenue from foreign firms	-1.58	48.52	-10.24	1.63
Local tax revenue from domestic firms	-2.32	14.20	-13.76	0.35
Local Welfare	0.14	-0.10	0.12	-0.00
National output of foreign firms	-0.09	-1.90	-0.01	-0.00
National output of domestic firms	0.10	0.71	0.01	0.00
National tax revenue from foreign firms	-0.15	17.03	-0.01	0.02
National tax revenue from domestic firms	-0.59	0.77	-0.17	-0.00
National Welfare	0.00	0.22	0.00	0.00

Counterfactual #1: China's Corporate Tax Reform

Table: Model Fit of Variation Across Provinces

	Regional Shares			MNEs Regional Shares			MNEs Local Contribution		
Actual changes	Output	Tax Revenue	Export	Output	Tax Revenue	Export	Output	Tax Revenue	Export
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Model prediction	2.92*	0.76***	1.30***	1.35***	0.15	0.27*	0.60**	0.54*	0.72***
	(1.46)	(0.28)	(0.42)	(0.16)	(0.30)	(0.14)	(0.26)	(0.26)	(0.25)
Observations	30	30	30	30	30	30	30	30	30
R-squared	0.12	0.21	0.25	0.70	0.01	0.11	0.15	0.13	0.23

Notes: This table regresses observed changes in the data for the period 2007 - 2013 on the model's predicted changes after the tax reform. The first three columns examine respectively the changes in provincial shares of national output, tax revenues, and exports. Columns (4)-(6) examine respectively the changes in provincial shares of national output, tax revenues, and exports generated by MNEs. Columns (7)-(9) examine the changes in the share of multinational firms in regional output, tax revenue, and exports, respectively. All regressions are weighted by the initial-period outcome variables. Standard errors are in parentheses.

Counterfactual #1: China's Corporate Tax Reform in 2008

Table: Percentage Changes in Aggregate Outcomes of the 2008 Corporate Tax Reform

	GDP			Tax Revenue			Welfare	Theil index
	Total	MNEs	Domestic Firms	Total	MNEs	Domestic Firms		GDP
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
National	-0.13	-6.88	3.10	2.23	54.89	-12.22	0.80	-1.14
Coastal & Central	-0.18	-8.10	4.20	4.25	55.63	-11.23	0.78	-1.38
Western	0.17	19.46	-2.20	-15.05	37.02	-19.27	0.86	-0.10

Counterfactual #2: Regional Corporate Tax Competition in China

- Counterfactual: each province maximizes its real income by deciding its local corporate tax rates on domestic and foreign firms, given other provinces' tax rates.

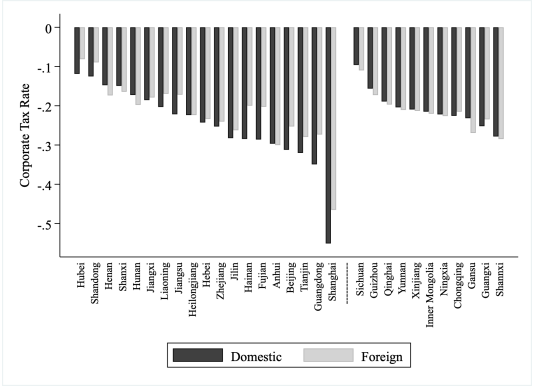


Figure: Nash Equilibrium of Regional Tax Competition in China

Counterfactual #2: Regional Corporate Tax Competition in China

Table: Percentage Changes in Aggregate Outcomes of Regional Tax Competition

	GDP			Tax Revenue			Welfare	Theil index
	Total	MNEs	Domestic Firms	Total	MNEs	Domestic Firms		GDP
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
National	7.84	6.61	8.43	-393.54	-532.51	-355.41	-5.57	23.94
Coastal & Central	10.01	5.51	12.50	-394.06	-519.73	-356.21	-4.05	27.01
Western	-6.62	30.31	-11.16	-364.89	-669.41	-340.22	-9.31	-4.65

Counterfactual #2: Regional Corporate Tax Competition in China

Without Foreign Multinationals

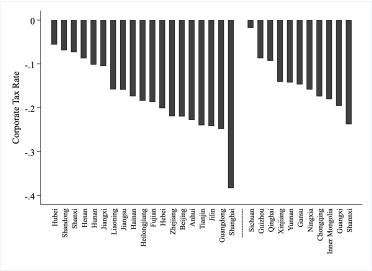


Figure: Nash Equilibrium of Regional Tax Competition

Table: Percent Changes in Aggregate Outcomes

	GDP	Tax Revenue	Welfare	Theil Index
	(1)	(2)	(3)	(4)
National	5.05	-274.06	-2.04	17.73
Coastal & Central	6.56	-273.19	-1.06	20.06
Western	-4.42	-269.29	-4.42	-2.81

Counterfactual #3: The Optimal Corporate Taxes in China

- Counterfactual: China's central government chooses $(\tilde{\kappa}_{j\ell})_{\ell=1}^{N}$ to maximize the population-weighted aggregate welfare changes.

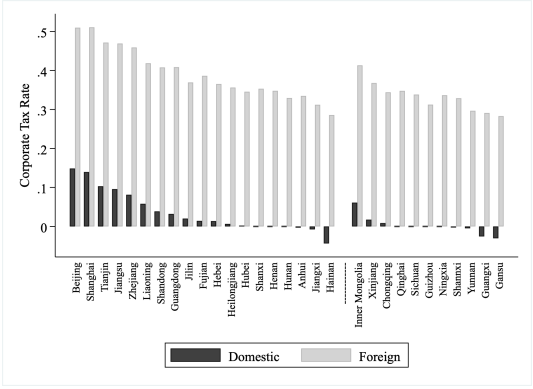


Figure: Optimal Corporate Taxes in China: Fixed Tax Revenue

Counterfactual #3: The Optimal Corporate Taxes in China

Table: Percentage Changes in Aggregate Outcomes of Optimal Taxes: Fixed Revenue

	GDP			Tax Revenue			Welfare	Theil index
	Total	MNEs	Domestic Firms	Total	MNEs	Domestic Firms		GDP
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
National	-2.78	-53.17	21.31	0.00	170.89	-46.89	3.09	-6.49
Coastal & Central	-3.24	-55.33	25.50	6.95	163.06	-40.07	2.77	-7.29
Western	0.27	-6.69	1.12	-56.46	404.36	-93.80	3.87	0.75

Counterfactual #3: The Optimal Corporate Taxes in China

Without Foreign Multinationals

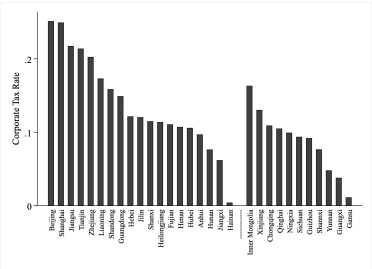


Figure: Optimal Corporate Taxes: Fixed Tax Revenue

Table: Percent Changes in Aggregate Outcomes

	GDP	Tax Revenue	Welfare	Theil index of GDP
	(1)	(2)	(3)	(4)
National	-0.54	0.00	0.06	-3.00
Coastal & Central	-0.71	4.07	0.03	-3.38
Western	0.49	-37.27	0.15	0.04

Conclusion

- We develop a spatial model with MP and local corporate taxes to quantify the aggregate impacts of local corporate tax policies

    1. China's corporate tax reform: it shifted foreign multinationals to western provinces and increased the aggregate welfare by 0.80%
    2. Regional corporate tax competition reduces aggregate welfare and significantly magnifies regional inequality
    3. Optimal corporate taxes: uniformly high corporate taxes on foreign and low taxes on domestic firms; welfare improvement is substantial, as is regional equality

- The presence of foreign MNEs exacerbates the welfare losses from corporate tax competition and increases the gains from optimal taxation

- Useful baseline for future work: incentives to subsidizing foreign multinationals, *e.g.* technology spillovers, input-output linkages, quality advantages, labor market outcomes

Thank you!

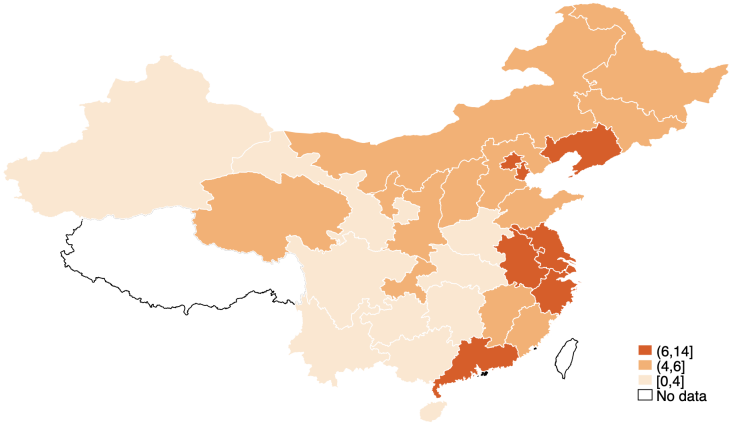


Figure: Corporate Tax Gaps between Domestic and Foreign Firms in China

(Notes: Corporate tax gap is equal to the effective corporate tax rate on domestic firms (in %) minus that on foreign firms. The data is for the year 2007. Data source: Annual Survey of Industrial Firms in China. Back)

FDI and FDI Policies in Developing countries

- FDI inflows to developing countries were about $12.5 billion (25% of the world's total FDI inflows) in 1980 and $837 billion (53%) in 2021.
- The share of FDI in GDP of developing countries increases from about 4.5% in 1980 to 20.4% in 2021.
- In 2021, 87% of measures that were favorable to MNE investment were undertaken in developing countries. In contrast, the majority of the measures (76%) adopted by developed countries introduced or reinforced investment restrictions.

Back

Empirical Results

Back

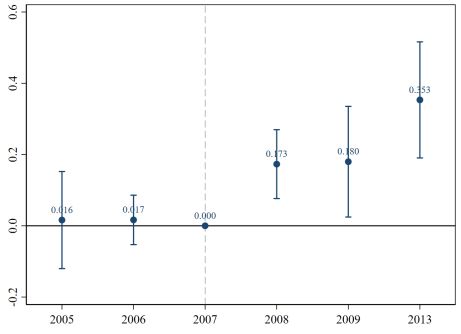
Table: Baseline Results

Dependent var	OLS	Baseline IV			Robustness			
$\log(X_{j\ell t})$		Reduced Form	First Stage	Second Stage	Drop SOEs	Diff Sampling	Weighted $\tilde{\kappa}_{j\ell t}$	Unbalanced Panel
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Province-level regressions								
$\log(1-\tilde{\kappa}_{j\ell t})$	11.76**			12.31**	13.80*	12.01**	10.75*	13.07**
	(4.48)			(5.41)	(7.36)	(5.80)	(5.94)	(6.15)
Foreign × *West* × *Post*07		0.22***	0.02***					
		(0.07)	(0.01)					
Baseline controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Kleibergen-Paap stat.				10.26	8.32	9.97	7.00	8.04
Observations	360	360	360	360	360	360	360	370
R-squared	0.97	0.96	0.94	0.97	0.96	0.96	0.96	0.97

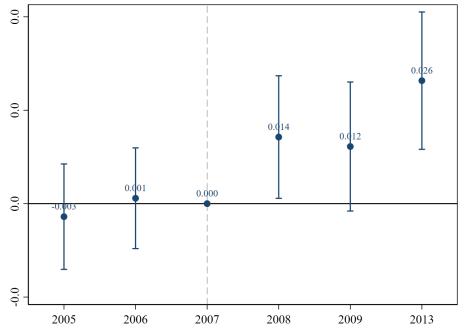
Notes: Columns (1) shows the OLS results, controlling for province-year, ownership-year and ownership-western region fixed effects. Columns (2) - (4) report the reduced form and IV estimation results. Columns (5)-(8) report the IV estimation results with regional output being computed excluding SOEs, using the same sample firms as Brandt et al. (2014), with the regional effective tax being averaged using firm output as weights, and with an unbalanced panel of data, respectively. Robust standard errors are clustered at the province level. *** p<0.01, ** p<0.05, * p<0.1.

Event Study City-level Evidence Robustness Extensive vs. Intensive Margins

Event Study



(a) Reduced Form



(b) First Stage

Notes: The points indicate estimated changes in regional output in response to tax changes (panel a) and tax reforms (panel b) in the event study design. The estimates are normalized to be compared with one period before the tax reform, which is displayed as an effect of 0 to aid the visual analysis. The bounds are given from the 90% confidence intervals, where standard errors are clustered at the province level. Note that there are serious quality issues with the ASIF data for 2010-2012; therefore, these years are excluded from all our analyses.

Back

City-level Evidence

Dependent var	OLS	Baseline IV			Robustness			
$\log(X_{jit})$		Reduced Form	First Stage	Second Stage	Drop SOEs	Diff Sampling	Weighted $\tilde{\kappa}_{jit}$	Unbalanced Panel
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
City-level regressions								
$\log(1-\tilde{\kappa}_{jit})$	2.76**			10.92**	11.53**	10.85**	8.75**	15.82**
	(1.08)			(4.81)	(5.41)	(5.13)	(4.12)	(6.80)
Foreign × *West* × *Post*07		0.21***	0.02***					
		(0.07)	(0.01)					
Baseline controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Kleibergen-Paap stat.				13.69	11.22	11.92	12.58	9.68
Observations	3,432	3,432	3,432	3,432	3,420	3,420	3,432	3,720
R-squared	0.91	0.91	0.83	0.90	0.89	0.90	0.89	0.90

Notes: Columns (1) shows the OLS results, controlling for city-year, ownership-year and ownership-western city fixed effects. Columns (2) - (4) report the reduced form and IV estimation results. Columns (5)-(8) report the IV estimation results with regional output being computed excluding SOEs, using the same sample firms as Brandt et al. (2014), with the regional effective tax being averaged using firm output as weights, and with an unbalanced panel of data, respectively. Robust standard errors are clustered at the city level. *** p<0.01, ** p<0.05, * p<0.1.

Back

Robustness - Province-level

Dependent var	Province-level Estimates				
$\log(X_{j\ell t})$	Financial Crisis	Infrastructure	Δ FDI Policy	Anticipation	Survey Threshold
	(1)	(2)	(3)	(4)	(5)
$\log(1-\tilde{\kappa}_{j\ell t})$	27.17***	27.31***	11.69*	12.45**	12.05*
	(9.62)	(9.45)	(5.83)	(5.34)	(6.08)
Finance× Foreign × Post07	27.11***				
	(8.85)				
Construction× Foreign × Post07		13.23***			
		(4.10)			
FDI^{+} × Foreign × Post07			-2.22		
			(3.86)		
FDI^{-} × Foreign × Post07			-10.43*		
			(5.70)		
Baseline controls	Yes	Yes	Yes	Yes	Yes
Kleibergen-Paap stat.	14.14	13.31	8.61	9.15	8.05
Observations	360	360	360	180	360
R-squared	0.96	0.96	0.97	0.96	0.96

Notes: Columns (1)-(2) show IV estimation results controlling for the interaction of Foreign and Post07 dummies with the regional share of employment in the finance and construction sectors, respectively. Columns (3) show IV estimation results controlling the change of encouraged industries in the central and western regions in 2008. FDI^{+} (FDI^{-}) denotes the initial regional share of foreign employment in newly encouraged (removed) industries in a given central or western province in the 2008 FDI catalogue. Column (4) uses only years 2005, 2007 and 2013 to address the potential anticipation effect in 2008-2009. Column (5) uses the sample of firms such that the reporting cutoff (prime operating revenue) is 20 million for all years. Robust standard errors are clustered at the corresponding regional level.*** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Robustness - City-level

Dependent var	City-level Estimates				
$\log(X_{j\ell t})$	Financial Crisis	Infrastructure	Δ FDI Policy	Anticipation	Survey Threshold
	(1)	(2)	(3)	(4)	(5)
$\log(1-\tilde{\kappa}_{j\ell t})$	16.30***	15.31***	11.88**	14.41**	11.60*
	(5.95)	(5.49)	(5.15)	(6.79)	(6.60)
Finance× Foreign × Post07	26.46***				
	(5.30)				
Construction× Foreign × Post07		6.52*			
		(3.81)			
FDI^{+} × Foreign × Post07			3.07**		
			(1.19)		
FDI^{-} × Foreign × Post07			-1.68		
			(5.18)		
Baseline controls	Yes	Yes	Yes	Yes	Yes
Kleibergen-Paap stat.	15.22	20.32	13.80	7.97	7.22
Observations	3,432	3,432	3,432	1,716	3,372
R-squared	0.89	0.89	0.90	0.89	0.89

Notes: Columns (1)-(2) show IV estimation results controlling for the interaction of Foreign and Post07 dummies with the regional share of employment in the finance and construction sectors, respectively. Columns (3) show IV estimation results controlling the change of encouraged industries in the central and western regions in 2008. FDI^{+} (FDI^{-}) denotes the initial regional share of foreign employment in newly encouraged (removed) industries in a given central or western province in the 2008 FDI catalogue. Column (4) uses only years 2005, 2007 and 2013 to address the potential anticipation effect in 2008-2009. Column (5) uses the sample of firms such that the reporting cutoff (prime operating revenue) is 20 million for all years. Robust standard errors are clustered at the corresponding regional level.*** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Back

Extensive vs. Intensive Margin Adjustments

Dependent var	Province-level		City-level	
$\log(X_{j\ell t})$	Extensive	Intensive	Extensive	Intensive
	(1)	(2)	(3)	(4)
$\log(1-\tilde{\kappa}_{j\ell t})$	13.76*	-1.45	9.84***	1.08
	(7.70)	(5.80)	(3.65)	(2.94)
Baseline controls	Yes	Yes	Yes	Yes
Kleibergen-Paap stat.	10.26	10.26	13.69	13.69
Observations	360	360	3,432	3,432
R-squared	0.97	0.93	0.94	0.82

Notes: Columns (1)-(2) show IV estimation results of extensive and intensive margin adjustments at the province-year level. Columns (3)-(4) show the same estimation results at the city-year level. In both cases region-year are balanced and the sampling firms used to compute regional output and effect cooperate tax is the same as the baseline case. Robust standard errors are clustered at the corresponding regional level. . *** p<0.01, ** p<0.05, * p<0.1.

Back

Firm's Problem

- $\zeta_{j\ell n}$: the probability that a firm originated from country j serves region n by its affiliate in region ℓ, conditional on its entry into n

$$\zeta_{j0n} = \frac{B_0(\xi_{j0n}\kappa_{j0})^{-\epsilon}}{\left[\sum_{k=1}^{N} B_k(\xi_{jkn}\kappa_{jk})^{-\frac{\epsilon}{1-\rho}}\right]^{1-\rho} + B_0(\xi_{j0n}\kappa_{j0})^{-\epsilon}}$$

$$\zeta_{j\ell n} = \frac{\left[\sum_{k=1}^{N} B_k(\xi_{jkn}\kappa_{jk})^{-\frac{\epsilon}{1-\rho}}\right]^{1-\rho}}{\left[\sum_{k=1}^{N} B_k(\xi_{jkn}\kappa_{jk})^{-\frac{\epsilon}{1-\rho}}\right]^{1-\rho} + B_0(\xi_{j0n}\kappa_{j0})^{-\epsilon}} \frac{B_\ell(\xi_{j\ell n}\kappa_{j\ell})^{-\frac{\epsilon}{1-\rho}}}{\sum_{k=1}^{N} B_k(\xi_{jkn}\kappa_{jk})^{-\frac{\epsilon}{1-\rho}}}, \quad \ell \neq 0 \tag{3}$$

- MP and trade flows

$$\psi_{j\ell n} \equiv \frac{X_{j\ell n}}{X_{jn}} = \frac{\zeta_{j\ell n}\kappa_{j\ell}^{\sigma-1}}{\sum_{k=0}^{N} \zeta_{jkn}\kappa_{jk}^{\sigma-1}}, \quad \lambda_{jn} \equiv \frac{X_{jn}}{X_n} = \frac{M_j T_j \Phi_{jn}^{-\theta} \Psi_{jn}}{\sum_h M_h T_h \Phi_{hn}^{-\theta} \Psi_{hn}}, \tag{4}$$

where

$$\Phi_{jn} \equiv \left\{ \left[\sum_{k=1}^{N} B_k(\xi_{jkn}\kappa_{jk})^{-\frac{\epsilon}{1-\rho}} \right]^{1-\rho} + B_0(\xi_{j0n}\kappa_{j0})^{-\epsilon} \right\}^{-\frac{1}{\epsilon}}, \quad \Psi_{jn} \equiv \sum_{k=0}^{N} \zeta_{jkn}\kappa_{jk}^{\sigma-1} \tag{5}$$

Back

Migration Decisions

- The probability that a worker born in o chooses to live in i is:

$$\pi_{oi} = \frac{A_i \left(\frac{1}{d_{oi}} \frac{X_i}{L_i P_i} \right)^{\eta}}{\sum_{k=1}^{N} A_k \left(\frac{1}{d_{ok}} \frac{X_k}{L_k P_k} \right)^{\eta}} \tag{6}$$

- The labor living in Home region $i = 1, \ldots, N$ is given by

$$L_i = \sum_{o=1}^{N} \pi_{oi} \bar{L}_o \tag{7}$$

Back

Equilibrium Conditions

- Labor markets clearing

$$w_i L_i = \left(1 - \frac{1}{\sigma}\right) \sum_j \sum_{n=0}^{N} X_{jin} + \delta \sum_j \frac{X_{ji}}{\Psi_{ji}}. \tag{8}$$

- Goods markets clearing

$$\begin{aligned} X_i &= w_i L_i + r_{iH} \Pi_H + \sum_{\ell=1}^{N} s_{i\ell} \Lambda_\ell, \quad i = 1, \ldots, N \\ X_0 &= w_0 \bar{L}_0 + \Pi_F + \Lambda_0, \end{aligned} \tag{9}$$

where

$$\Pi_j = \sum_{\ell=0}^{N} \sum_{n=0}^{N} \left[\frac{1}{\sigma} \kappa_{j\ell}^{1-\sigma} X_{j\ell n} - \delta \zeta_{j\ell n} \frac{X_{jn}}{\Psi_{jn}} \right], \quad \Lambda_\ell = \sum_j \sum_{n=0}^{N} \frac{1}{\sigma} \left(1 - \kappa_{j\ell}^{1-\sigma}\right) X_{j\ell n}. \tag{10}$$

- Price index

$$P_n^{-\theta} = \frac{\theta \sigma^{-\frac{\theta-(\sigma-1)}{\sigma-1}} \tilde{\sigma}^{-\theta}}{\theta - (\sigma - 1)} \left[\frac{w_n F_n}{X_n} \right]^{-\frac{\theta-(\sigma-1)}{\sigma-1}} \sum_j M_j T_j \Phi_{jn}^{-\theta} \Psi_{jn} \tag{11}$$

Back

Utility Function and Welfare Measures

- Utility function:

$$U_{oi}(\nu) = \frac{a_i(\nu)}{d_{oi}} \left[\int_{\Omega_i} C_i(\nu,\omega)^{\frac{\sigma-1}{\sigma}} d\omega \right]^{\frac{\sigma}{\sigma-1}}, \quad \sigma > 1 \tag{12}$$

- Welfare:

$$W_o = \left[\sum_{k=1}^{N} A_k \left(\frac{1}{d_{ok}} \frac{X_k}{L_k P_k} \right)^{\eta} \right]^{\frac{1}{\eta}} \tag{13}$$

$$W = \sum_{o=1}^{N} \frac{\bar{L}_o}{\sum_{k=1}^{N} \bar{L}_k} W_o \tag{14}$$

Back

Data for Empirical Estimation

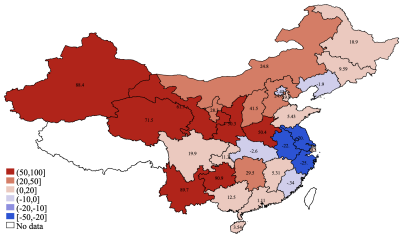
- Annual Survey of Industrial Enterprises (ASIF)
  - contains detailed firm-level information, including location, ownership, and accounting information, such as sales, employment, capital stock, material inputs, payroll, and exports
  - allows us to measure the total firm output and the effective corporate tax rate
  - We use this data for the years 2005–2013, with years 2010-2012 being excluded for a well-known quality issues
- Effective corporate tax rate at the firm level

$$\text{effective corporate tax rate} = \frac{\text{income tax payable}}{\text{profit before tax}}$$

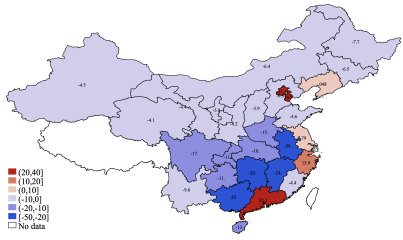
Then take simple average to get $\tilde{\kappa}_{j\ell t}$

Back

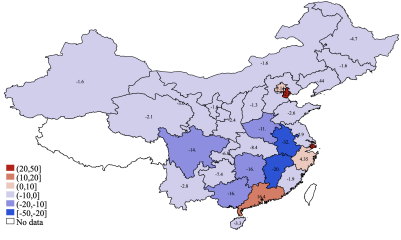
Counterfactual #2: Regional Corporate Tax Competition in China



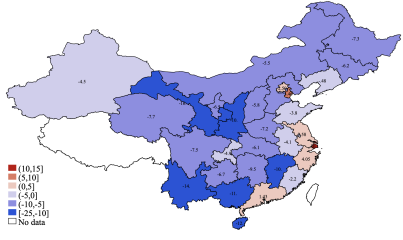
(c) MNEs Production



(d) Domestic-firm Production

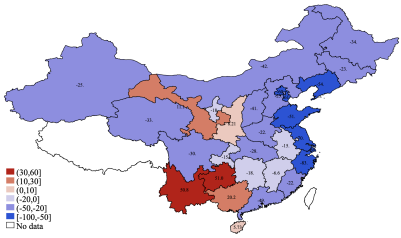


(e) GDP

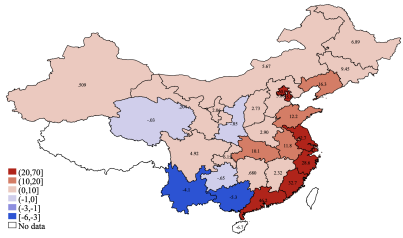


(f) Welfare

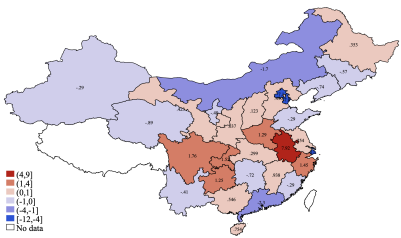
Counterfactual #3: The Optimal Corporate Taxes in China: Fixed Tax Revenue



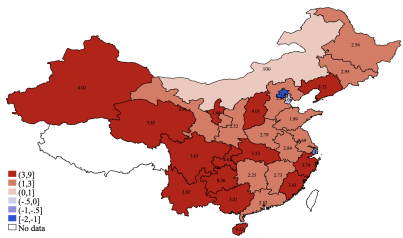
(a) MNEs Production



(b) Domestic-firm Production



(c) GDP



(d) Welfare