Spatial Misallocation across Chinese Firms

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May 2018 @ ABFER

Motivation

- Resource misallocation due to frictions at micro level exerts great impacts on the aggregate outcome.
- The microeconomic frictions are often rooted in institutions that vary across regions even within the same country.
- How does the spatial dispersion of the micro-level frictions influence the distribution of economic activities across regions?

What We Do

We explore the spatial dimension of the micro-level frictions in the case of China.

- We document the micro-frictions vary systematically across cities.
- We develop a quantitative framework with the following features:
  - heterogeneous firms with inter-city trade and endogenous entry and exit decisions.
  - two types of firms: state-owned and non-state firms, two types of frictions: output and labor frictions.
  - both frictions are city-ownership specific.
- We calibrate the model to the Chinese economy, and then evaluate the welfare impacts of these frictions with a series of counter-factual exercises.

Results: the Aggregate and Local Impacts

- Eliminating all the frictions in year 2007 leads to a 10.5 percent increase in the aggregate welfare, and reduce the spatial inequality by around 5.0 percent.
- The spatial disparity of frictions is responsible for 54% of the welfare gain, and almost 100% of the reduction of spatial inequality.

Main Contributions

- We highlight the spatial dispersion of frictions in itself is costly to both the aggregate welfare and the spatial inequality.
- Theoretically, we extend the works of Hsieh and Klenow(2009) by introducing internal trade and endogenous firm entry and exit
- Empirically, we estimate city-level frictions using firm-level data, and takes into account the real world geography. We show that labor and output distortions systematically differ across types of firms and location.
- Our model is flexible yet quantitatively implementable, and allows us to quantify the aggregate and distributional impacts of frictions at micro-level.

Literature Review

- **Misallocation**: Hsieh and Klenow (2009), Restuccia and Rogerson (2008), Francisco, Joseph, Yongseok, et al. (2011), Guner, Ventura, and Xu (2008), Tombe and Zhu(2015), Brandt, Tombe and Zhu (2013) ,Hsieh and Moretti(2015).

- **Chinese Economy**: Brandt, Hsieh and Zhu (2008), Song, Storesletten and Zilibotti (2011), Hsieh and Song (2015), Ma and Tang (2016),Hopenhayn(2014).

Theoretical Framework

Model Environment

- The economy contains $J > 1$ geographically segmented cities, indexed by $j = 1, 2...J$. Labor endowment in each city j is exogenously given as L_j. Labor is not allowed to move across cities.
- There are two type of firms in each city j, namely, state-owned firms and private firms, denoted as type S and N, respectively.
- Individual workers in city j gain utilities from consuming the set of varieties available in the city they reside in:

$$U_j = \underbrace{\left[\sum_{k \in \Omega_j} y(k)^{\frac{\varepsilon-1}{\varepsilon}} \right]^{\frac{\varepsilon}{\varepsilon-1}}}_{Y_j}$$

where $\varepsilon > 0$ represents the elasticity of substitution among all the varieties.

Production

- Each variety requires input bundles to produce.
- Input bundle requires local labor and composite varieties as inputs:

$$F(L_j, Y_j) = L_j^{\beta} Y_j^{1-\beta}$$

- Firms are heterogeneous in term of their input bundle requirements for producing one unit of output, a, from a Pareto distribution:

$$Prob(\frac{1}{a} \leq x) = 1 - (\frac{\mu}{x})^{\theta}$$

Firm's Timeline

- Potential firms pay f_e units of input bundles to enter the market. After entry, firms realize their productivity and type simultaneously from two independent distributions.
- With possibility $\lambda_i > 0$ the firm will become state-owned, and $1 - \lambda_i$ become private in city i.
- After observing their productivity and firm type, firms choose which markets to serve (or immediately exit the market). In order for a firm from city j to serve city i, a fixed operating cost f_{ij} in term of input bundles of city j needs to be paid. Trade is subject to iceberg cost $1 + t_{ij} > 1$.

Firm's Frictions

- We follow Hsieh and Klenow [2009] by introducing two types of frictions in the economy: output (τ_y) and labor friction (τ_ℓ).
  - Output friction restricts firm size, and labor friction distorts the relative cost of labor versus intermediate inputs within the firm.
- Frictions are **city-and-type** specific: we use $\tau^S_{y,j}$ and $\tau^N_{y,j}$ to denote output frictions in city j for state-owned firms and private firms, and $\tau^S_{\ell,j}$ and $\tau^N_{\ell,j}$ for labor frictions for two types of firms, respectively.

Firm's Decision

- The expenditure on an input bundle for firms of type d in city j:

$$c_j^d = (1-\beta)^{\beta-1}\beta^{-\beta}\left[\left(1+\tau_{\ell,j}^d\right)w_j\right]^{\beta}P_j^{1-\beta}, \quad d = S, N$$

- Firm of type d with input bundle requirement a in city j will serve city i iff the variable profits can cover the fixed operation costs:

$$\max_{p_i^d(k)} \quad (1-\tau_{y,j}^d)p_i^d(k)q_i(k) - a(k)t_{ij}q_i(k)c_j^d - f_{ij}c_j^d$$

$$s.t. \quad q_i(k) = \frac{X_i}{P_i^{1-\varepsilon}}p_i^d(k)^{-\varepsilon}.$$

where X_i is the total expenditure on final consumption goods in city i.

Free Entry

- Free entry condition in city j can be used to pin down the mass of firms.

$$\lambda_i E\left[\sum_{i=1}^{J} \mathbf{1}\left(a(k) < a_{ij}^{S}\right) \pi_{ij}^{S}(a)\right] + (1-\lambda_i) E\left[\sum_{i=1}^{J} \mathbf{1}\left(a(k) < a_{ij}^{N}\right) \pi_{ij}^{N}(a)\right] = f_e \bar{c}_j$$

  where a_{ij}^{d} $(d = S, N)$ is the cutoff input bundle requirement below which firm in city j and production type d will serve city i.

- We assume there is no distortion before the realization of the firm type. $\bar{c}_j$ is the expenditure on an input bundle at entry-stage, and thus it equals:

$$\bar{c}_j = w_j^{\beta} P_j^{1-\beta}$$

Equilibrium

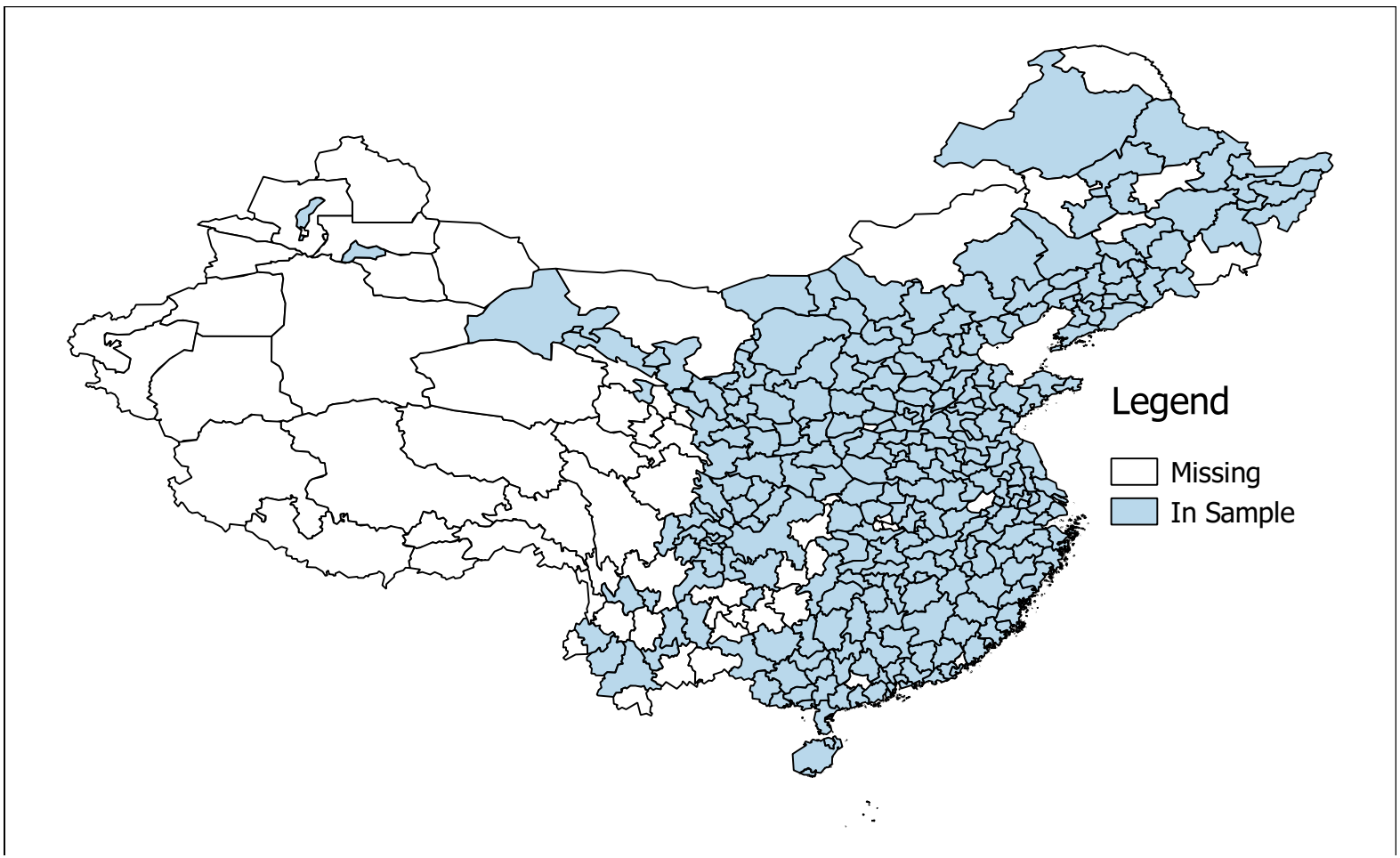
The equilibrium contains a series of values $\{X_j^S, X_j^N\}_{j=1}^J$, a series of prices $\{w_j, P_j\}_{j=1}^J$ and a sequence of quantities $\{I_j^S, I_j^N, L_j^S, L_j^N\}_{j=1}^J$ such that the following conditions hold:

1. Workers maximize their utilities by choosing final goods consumption.
2. Firms maximize their profit by choosing the quantity to sell to each market and the price for the variety.
3. The free entry condition holds in each city.
4. The labor market clears in each city.
5. Trade balance.

Calibration and Estimation

Calibration

We focus on a selection of 279 prefecture-level cities due to data restrictions: our sample contains all the cities that are included in the Chinese City Statistical Yearbooks, Annual Surveys of Industrial Firms and the One-Percent Population Survey in 2005.



Estimation of Output and Labor Frictions: Data

- Our firm-level data comes from the Annual Surveys of Industrial Firms conducted by NBS.

Table: Summary Statistics for 2007 Sample

(a) State-Owned Firms

Variable	Mean	Std. Dev	Min.	Max.	N
Total Sales	718,829	4,458,436	356	180,000,000	10,750
Employment	1,063	4,763	21	134,614	10,750
Value Added	238,303	1,591,135	1	60,486,000	10,750

(b) Private Firms

Variable	Mean	Std. Dev	Min.	Max.	N
Total Sales	110,860	958,913	300	195,000,000	257,335
Employment	213	831	21	188,151	257,335
Value Added	31,500	382,618	1	163,000,000	257,335

Estimation of Output and Labor Frictions

Solving firm $k's$ cost minimization or profit maximization problem gives:

$$\tau_{\ell,j}^{d}(k) = \frac{\beta_{m(k)}}{1-\beta_{m(k)}} \cdot \frac{P_j Y_j^d(k)}{w_j L_j^d(k)} - 1,$$

$$\tau_{y,j}^{d}(k) = 1 - \frac{1}{1-\beta_{m(k)}} \frac{\varepsilon}{\varepsilon - 1} \frac{P_j Y_j^d(k)}{R_j^d(k)},$$

where

- $m(k)$ is the industry and $\beta_{m(k)}$ is the labor intensity.
- $w_j L_j^d(k)$ is the total wage bill, and $P_j Y_j^d(k)$ is the firm's non-labor cost: the expenditure on intermediate goods and the cost of capital.
- $R_j^d(k)$ is sales revenue.

Estimation of Output and Labor Frictions

- We use the *Annual Surveys* to estimate $\beta_{m(k)}$ for 491 industries at the 4-digit level.
- We compute the city-specific (or city-type-specific) frictions as the weighted average within each city (city-type):

$$\tau_{\ell,j} = \sum_k \tau_{\ell,j}(k)\,\omega_{jl}(k)\,,$$

$$\tau_{y,j} = \sum_k \tau_{y,j}(k)\,\omega_{jy}(k)\,.$$

Map: Frictions

Summary Statistics: city-level frictions

(a) Output Frictions

Year	Mean	Sd	P10	P25	Median	P75	P90
1998	0.044	0.103	-0.065	-0.025	0.027	0.091	0.162
1999	0.041	0.110	-0.068	-0.035	0.018	0.086	0.190
2000	0.028	0.100	-0.078	-0.031	0.015	0.066	0.134
2001	0.028	0.086	-0.067	-0.028	0.017	0.066	0.129
2002	0.023	0.080	-0.066	-0.024	0.011	0.057	0.126
2003	0.025	0.076	-0.055	-0.030	0.015	0.058	0.126
2004	0.013	0.067	-0.063	-0.032	0.008	0.048	0.096
2005	0.020	0.069	-0.060	-0.025	0.014	0.055	0.097
2006	0.027	0.075	-0.052	-0.015	0.018	0.056	0.106
2007	0.024	0.063	-0.056	-0.016	0.020	0.061	0.102
Total	0.027	0.085	-0.064	-0.026	0.016	0.063	0.126

(b) Labor Frictions

Year	Mean	Sd	P10	P25	Median	P75	P90
1998	0.085	0.310	-0.283	-0.134	0.066	0.255	0.533
1999	0.099	0.358	-0.297	-0.145	0.031	0.306	0.593
2000	0.077	0.317	-0.282	-0.154	0.039	0.246	0.554
2001	0.099	0.365	-0.273	-0.137	0.046	0.262	0.479
2002	0.078	0.311	-0.251	-0.133	0.038	0.249	0.439
2003	0.110	0.324	-0.243	-0.132	0.050	0.297	0.538
2004	0.019	0.253	-0.262	-0.152	-0.015	0.175	0.354
2005	0.040	0.259	-0.264	-0.138	-0.006	0.204	0.423
2006	0.034	0.295	-0.293	-0.178	-0.009	0.213	0.452
2007	0.078	0.327	-0.275	-0.155	0.006	0.277	0.500
Total	0.072	0.315	-0.272	-0.148	0.021	0.245	0.479

Frictions over Space

	Abs(Output Frictions)			Abs(Labor Frictions)		
	(1)	(2)	(3)	(4)	(5)	(6)
Ln(GDP)	-0.009***	-0.982	0.006	-0.014**	-5.163*	0.018
	(0.002)	(0.804)	(0.006)	(0.006)	(2.847)	(0.015)
Year		-0.005**			-0.015*	
		(0.002)			(0.009)	
Ln(GDP) × Year		0.000			0.003*	
		(0.000)			(0.001)	
N	2628	2628	2626	2628	2628	2626
R-squared	0.026	0.031	0.405	0.005	0.005	0.359
Year FE	No	No	Yes	No	No	Yes
City FE	No	No	Yes	No	No	Yes

Alternative Estimation

Within-city Frictions

LHS = (SOE) - (Private)	Output Frictions		Labor Frictions	
	(1)	(2)	(3)	(4)
Constants	0.053***	22.350***	-0.287***	-12.106
	(0.005)	(2.852)	(0.018)	(7.871)
Ln(Pop.)		0.012*		-0.015
		(0.006)		(0.024)
Year		-0.011***		0.006
		(0.001)		(0.004)
N	2700	2700	2700	2700
R-squared	0.000	0.044	0.000	0.001
City FE	No	No	No	No

Map: output Friction Map: labor Friction

Benchmark Parameterizations

- $\theta = 5.3$ and $\epsilon = 6$ (Di Giovanni and Levchenko 2012), so that the tail index of the firm size distribution is 1.06 (Axtell 2001).
- f_{ij} matrix is calibrated by following the strategy in Ma and Tang(2016) by approximating the fraction of entrepreneurs in each city among all working population in 2005 1-percent population survey.
- $f_e = 0.71$ is calibrated to match the number of firms in Shanghai, which is around 340 thousand.
- λ_i is chosen to match the SOE employment share from the Second Economic Census in 2008.
- Ice-berg trade cost is taken from Ma and Tang (2016).
- We scale the ice-berg trade cost matrix, $\bar{\tau} = 2.19$ to match the internal trade to GDP ratio (World Bank ICS 2005).

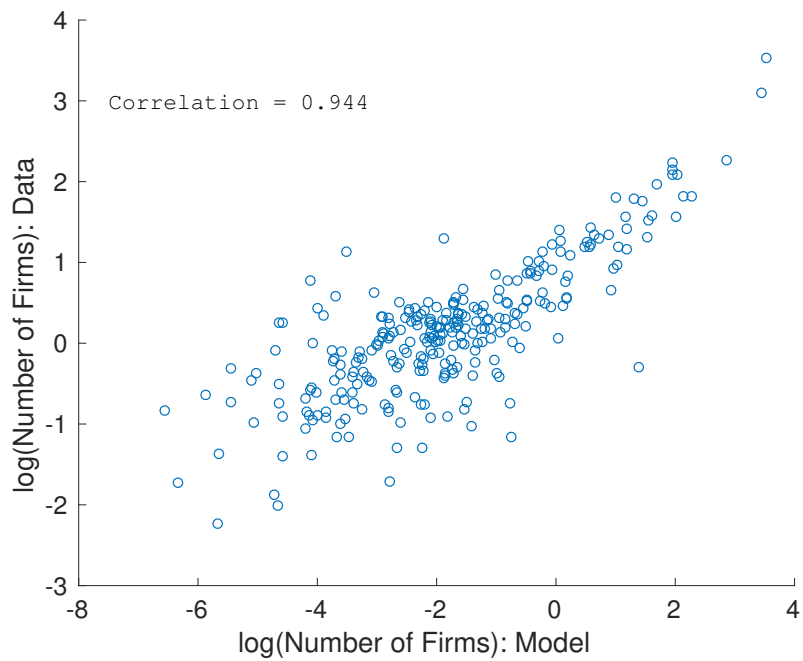
SOE Employment Share by Province

Province	Value (%)	Province	Value (%)
Anhui	34.99	Jiangsu	6.40
Beijing	37.75	Jiangxi	24.24
Chongqing	31.26	Jilin	41.47
Fujian	6.34	Liaoning	31.68
Gansu	61.62	Ningxia	49.94
Guangdong	5.21	Qinghai	60.85
Guangxi	30.03	Shaanxi	59.27
Guizhou	53.94	Shandong	17.03
Hainan	29.74	Shanghai	16.45
Hebei	29.32	Shanxi	53.30
Heilongjiang	56.95	Sichuan	29.27
Henan	28.54	Tianjin	29.45
Hubei	30.73	Xingjiang	67.88
Hunan	26.30	Yunnan	39.38
Inner Mogolia	38.99	Zhejiang	3.99

Table: SOE employment share by province

Model Fit

(a) GDP



(b) Number of Firms

Figure: Model Fit

Quantitative Results

Measurement of Welfare and Size of Distortions

- We measure welfare by the real disposable income:

$$\begin{aligned}\text{Welfare}_i &= \text{Real Disposable Income}_i \\ &= \frac{w_i L_i + \sum_{d=S,N}\left(\tau^d_{l,i} w_i L^d_i + \tau^d_{y,i} X^d_i\right)}{P_i}.\end{aligned}$$

- We measure the size of the distortions in city i by the ratio of the implied taxation revenue or deficit to local GDP:

$$\text{Size of Distortion}_i = \frac{\sum_{d=S,N}\left(\tau^d_{l,i} w_i L^d_i + \tau^d_{y,i} X^d_i\right)}{w_i L_i + \sum_{d=S,N}\left(\tau^d_{l,i} w_i L^d_i + \tau^d_{y,i} X^d_i\right)}.$$

Impacts of Frictions in 2007

	Benchmark	Frictionless	No Spatial Diff.	No Sect. Diff.	No Entry	1998
Real Income	255.37	282.27	283.65	273.03	269.53	243.10
	Size of Distortions					
Aggregate	-0.059	0.000	-0.036	0.028	0.000	-0.018
Output, SOE	0.020	0.000	0.022	0.015	0.000	0.063
Output, Private	-0.024	0.000	-0.045	0.000	0.000	-0.012
Labor, SOE	-0.076	0.000	-0.044	0.001	0.000	-0.086
Labor, Private	0.021	0.000	0.031	0.011	0.000	0.017
	Employment Share					
SOE	0.379	0.250	0.283	0.250	0.257	0.687
Private	0.621	0.750	0.717	0.750	0.740	0.312
	Number of Operating Firms					
Total	267.29	273.51	278.39	272.05	267.29	248.43
SOE	59.02	57.97	74.63	53.71	59.02	202.81
Private	208.26	215.54	203.76	218.34	208.26	45.62

Summary Labor reallocation Spatial Variations Within City Dif. Entry and Exit 1998

Impacts of Frictions in 2007

	Benchmark	Frictionless	No Spatial Diff.	No Sect. Diff.	No Entry	1998
	Inequality Measures					
Most Imp. City(%)	-	95.934	96.889	69.231	58.562	66.738
Least Imp. City(%)	-	-5.565	-5.103	-15.479	-4.582	-61.496
Coef. of variation	2.519	2.384	2.384	2.410	2.426	2.602
SD(LN(Real Income))	1.204	1.155	1.155	1.172	1.193	1.198
Real Income, P(90)/P(50)	5.036	4.671	4.671	4.785	5.025	4.963
Real Income, P(90)/P(10)	21.088	18.329	18.329	18.841	20.757	21.421
Real Income, P(50)/P(10)	4.188	3.924	3.924	3.937	4.131	4.316
	Trade Openness					
Trade Openness	0.623	0.617	0.617	0.620	0.616	0.625

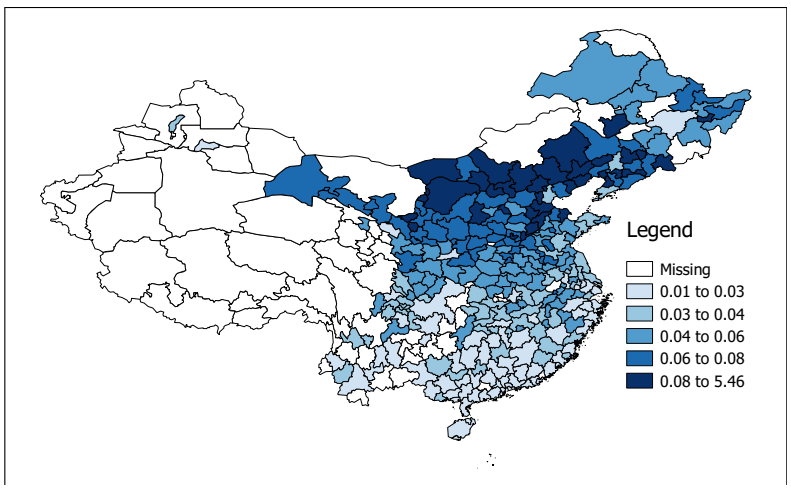
Friction Reduction at the Local Level

We explore the potential spillover mechanism by only removing frictions in Beijing or Shanghai, separately.

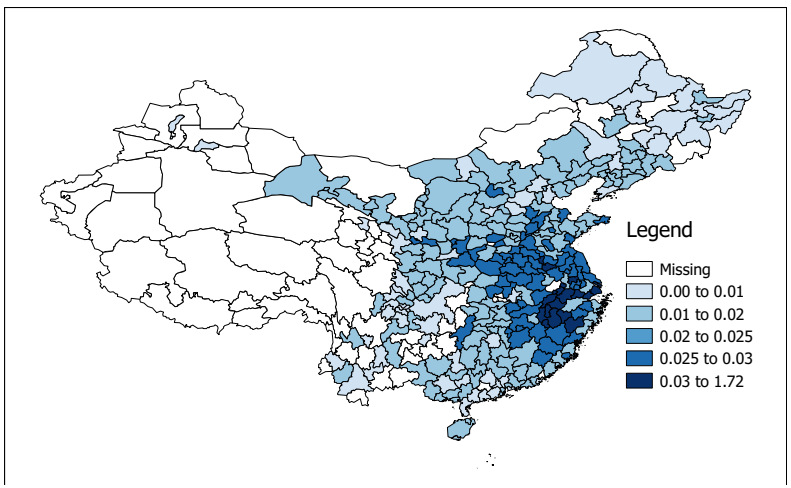
- Removing the frictions in Beijing or Shanghai improves the national welfare by 0.4 percent or 0.196 percent.
- Approximately 92 or 93.2 percent of the welfare gain accrue to Beijing or Shanghai. All the other cities still benefit through spillover:
  - lower marginal costs among the firms in Beijing and Shanghai benefit all firms in other cities that source from these cities.
  - firms in Beijing and Shanghai expand, which results in higher demand for the goods produced in all the other cities.
  - the benefits decrease with distance.

The Welfare Impacts from Removing Local Frictions

The spillover depends not only on the bilateral trade costs but also on the ease of access to other large markets.



(a) Beijing



(b) Shanghai

Concluding Remarks

- We propose a general equilibrium framework to evaluate the spatial impacts of micro-economic frictions.
- We show that the frictions in both the factor and the output markets vary systematically across cities, and the spatial disparity is persistent over time.
- The existing frictions divert workers toward the less productive SOEs, throttle firm entry in the private sectors, and overall lead to a 10.5 percent aggregate welfare loss in China.
- Removing the spatial disparity of the frictions increase the total output by 5.7 percent, and lower spatial inequality to the same extent as frictionless economy.

Summary of Results

- Removing all the frictions leads to a 10.5 percent gain of real income.
- The frictions in 2007 favor the SOEs: once the frictions are removed, the employment share of the SOEs dropped from 47.2 percent to 34.6 percent and the number of operating SOEs dropped by 1.8 percent.
- Removing the frictions in 2007 also lowers the coefficient of variation across city-level real income by around 5.4 percent, and the standard deviation of the logarithm of real income by around 4.1 percent.
- Removing all the frictions also slightly lowers the inter-city trade share.

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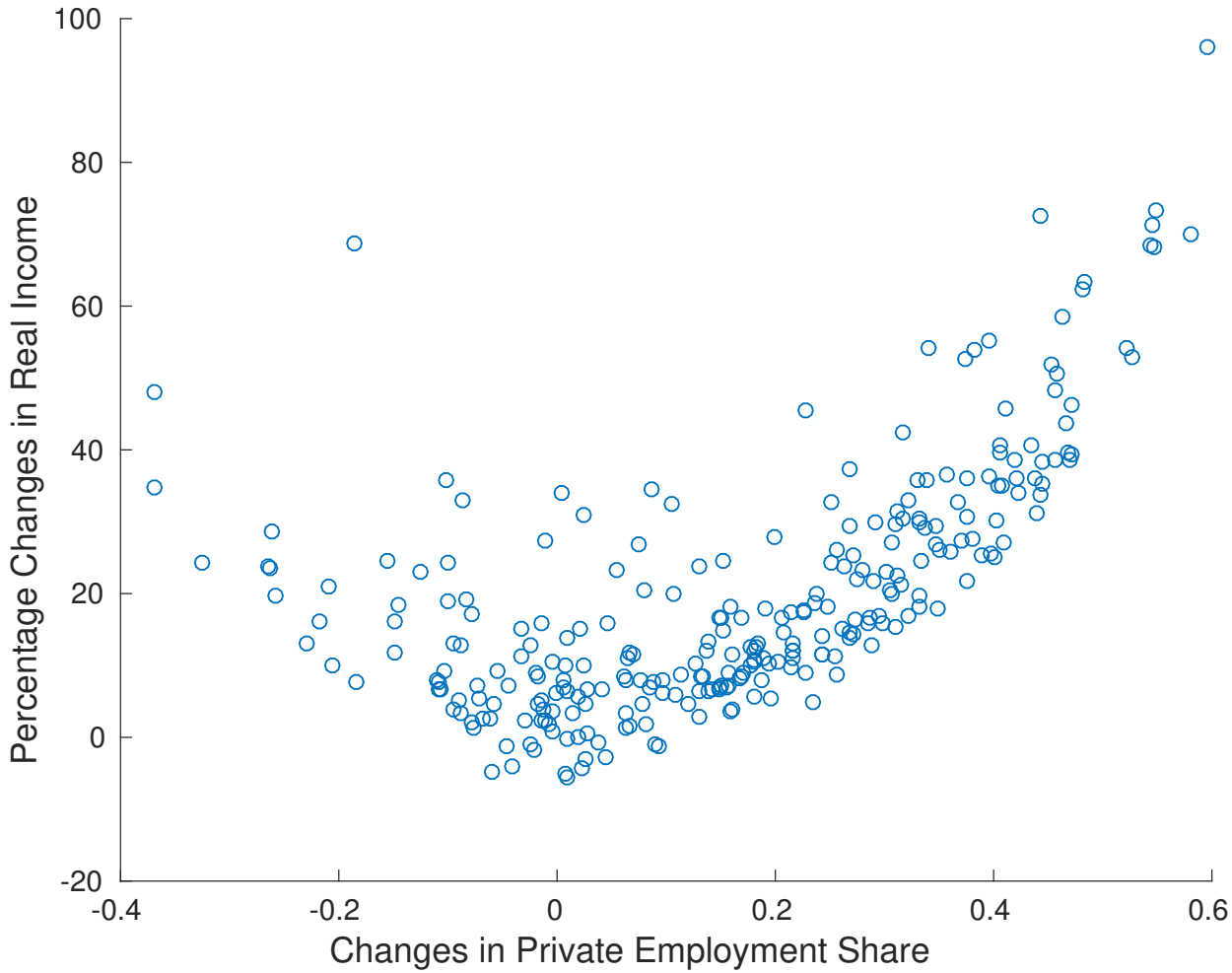
Employment, Sales, and Gains in Real Income



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The Spatial Variations of Frictions

Eliminate the spatial differences by setting the frictions in all city-type cells to national level.

- without spatial dispersion of frictions, the aggregate real income has increased by 5.7 percent, which is about 54.2 percent of the overall welfare gain towards the frictionless case.
- The main channel: the reallocation of economic activity to small cities. Removing the spatial disparity allows more firms in the smaller cities to survive and expand, and thus gain in the aggregate welfare.
- Removing the spatial differences in frictions also lowers the spatial inequality to levels almost identical to the frictionless case.

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Within-city Differences

we conduct a set of counter-factual analysis in which we only eliminate the differences of the frictions between SOEs and private firms within each city.

- Removing the within-city difference leads to a 6.9 percent increase in real income, which is around 65.7 percent of welfare gains in the frictionless case.
- This suggests the distortions induced by the SOEs impose a sizable cost on aggregate outcomes.

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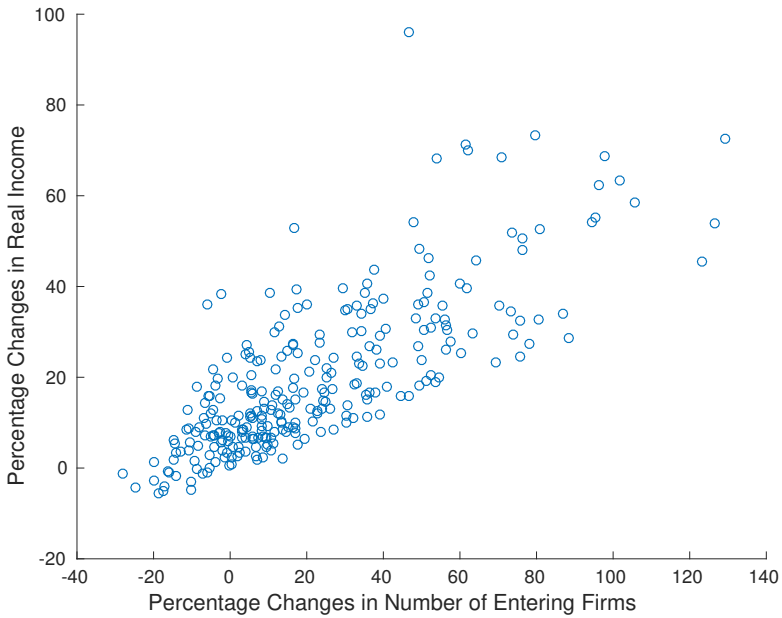
Firm Entry/Exit

- To evaluate the effects of the extensive margin, we carry out another set of counter-factual analysis, in which we fix the number of operating firms in each city-ownership cell to their values in the baseline model, and then remove all the frictions.
- Comparing to the baseline results, 47.6 percent of the gain in real income can be attributed to the changes in the extensive margin.

Firm Entry/Exit

The cities that benefited more in the frictionless economy tend to be those that experienced higher growth rates in firm entry and lower price index.



(c) Number of Entering Firms

(d) Ideal Price Index

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Changing Frictions between 1998 and 2017

(a) Frictions in 1998

Variable	Mean	Mean(Abs.)	Std. Dev.	Min.	Max.	N
SOE Output Friction	0.106	0.129	0.14	-0.168	0.632	279
Private Output Friction	0.016	0.061	0.089	-0.139	0.454	279
SOE Labor Friction	-0.281	0.339	0.259	-0.819	1.109	279
Private Labor Friction	0.019	0.290	0.405	-0.813	3.027	279

(b) Frictions in 2007

Variable	Mean	Mean(Abs.)	Std. Dev.	Min.	Max.	N
SOE Output Friction	0.049	0.095	0.118	-0.169	0.445	279
Private Output Friction	0.031	0.052	0.066	-0.101	0.492	279
SOE Labor Friction	-0.346	0.401	0.288	-0.805	1.418	279
Private Labor Friction	-0.07	0.242	0.299	-0.638	1.378	279

Changing Frictions between 1998 and 2017

- Output frictions among SOEs have decreased from 6.3 percent of the GDP in 1998 to 2.0 percent in 2007. The labor subsidies to SOE have shrunk from 8.6 to 7.6 percent of the GDP.
- The changes in frictions over the years had led to a 5.03 percent gain in aggregate welfare.
- The share of SOEs in the number of operating firms has drastically decreased from 81.64 percent in 1998 to 22.08 percent in 2007, and SOE employment share has decreased from 78 percent to 47.2 percent. This finding is consistent with the designated SOE reform policy grasp the large and let go of the small.
- The changes in frictions also seem to increase the spatial inequality slightly.

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Friction over Space

	Abs(Output Frictions)			Abs(Labor Frictions)		
	(1)	(2)	(3)	(4)	(5)	(6)
Ln(Pop.)	-0.014***	-2.118	-0.022	-0.027***	-3.071	0.031
	(0.002)	(1.330)	(0.024)	(0.010)	(4.246)	(0.067)
Year		-0.008**			-0.011	
		(0.003)			(0.010)	
Ln(Pop.) × Year		0.001			0.002	
		(0.001)			(0.002)	
N	2700	2700	2698	2700	2700	2698
R-squared	0.027	0.045	0.399	0.008	0.009	0.339
Year FE	No	No	Yes	No	No	Yes
City FE	No	No	Yes	No	No	Yes

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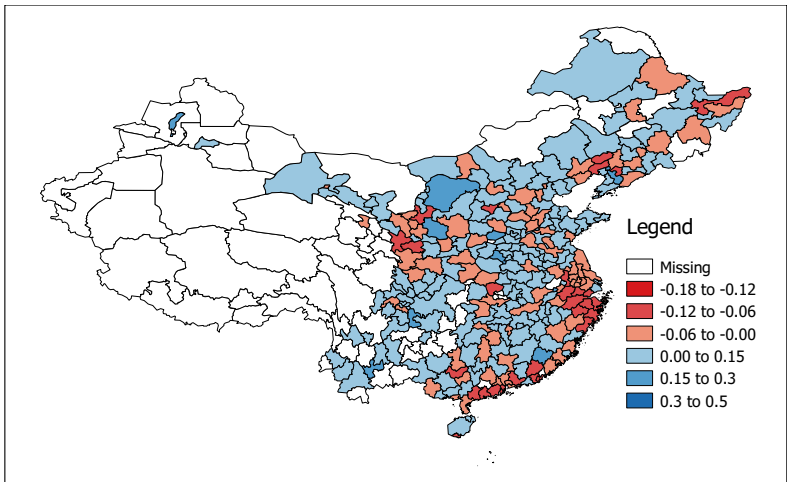
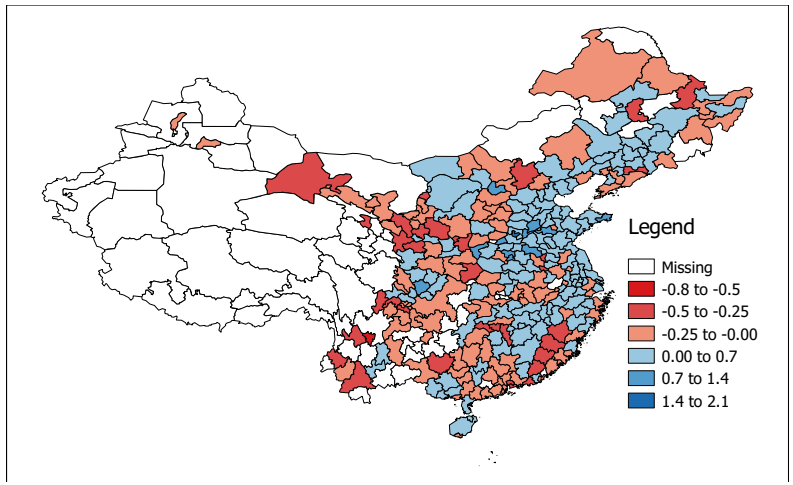
City-level Frictions



(e) Output Frictions



(f) Labor Frictions

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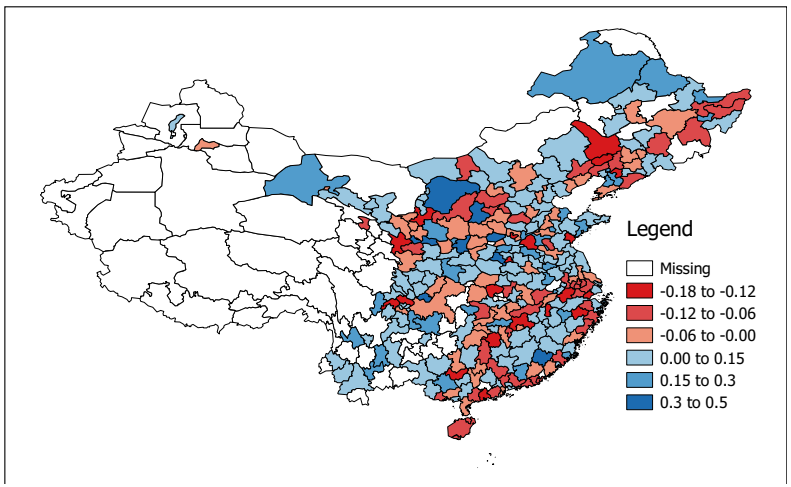
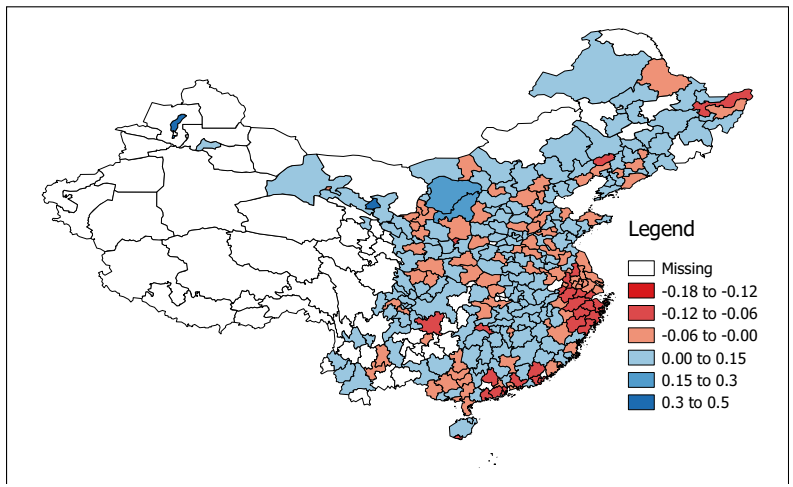
Output Frictions between SOE and Private Firms

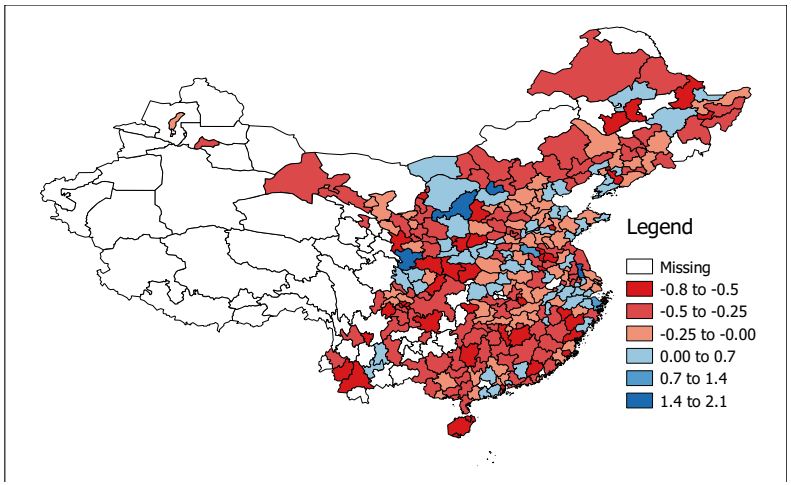


(g) Output Frictions, SOE

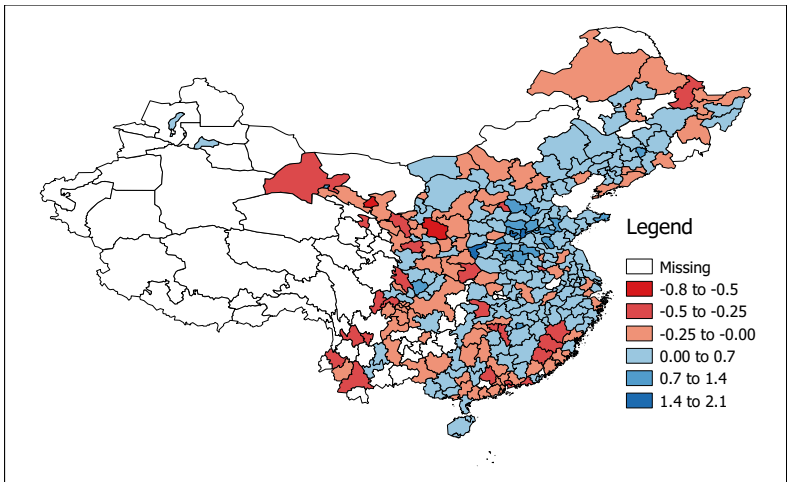


(h) Output Frictions, Private

Labor Frictions between SOE and Private Firms



(i) Labor Frictions, SOE



(j) Labor Frictions, Private

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