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DISCUSSION PAPER SERIES

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ABSTRACT

Provincial Trade, Financial Friction and Misallocation in China*

We study the implications of financial-market imperfections on labor and capital misallocation in China. Financial friction stems from private sectors' credit constraints that limit the efficient use of capital relative to state firms. Our model can jointly explain labor flows out of and capital flows into the Chinese provinces with high capital market distortion. To formally test this hypothesis, we propose a measure of regional financial friction based on our model. We show that the underlying financial friction can be inferred by differences-in-differences in the market shares of private and state sectors and their marginal rental rates of capital. Our regression results show that our measure of financial friction has robust explanatory power regarding interprovincial capital and labor flows. Our structural analysis shows that improving financial friction in China can lead to 3.9% welfare gain in China.

JEL Classification: R12, H3, E5, O5, F4
Keywords: financial friction, regional capital flows, Chinese economy

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1 Introduction

It is well established that inefficient allocation of productive capital has created a sizable gap between potential and realized production possibilities in China (Hsieh and Klenow, 2009).[1] Capital misallocation in China arises mainly from between-ownership financial friction – domestic private firms facing institutional barriers to capital markets (Poncet et al., 2010) – and inter-provincial friction that results from the central government's policy to favor capital usage in certain provinces (Boyreau-Debray and Wei, 2005).

We motivate our study by showing that Chinese provinces with high internal financial friction have been the net receivers of capital from other provinces. This is inconsistent with the common view in the international-macro literature where capital is believed to flow out from regions with high financial friction, such as developing countries (Gertler and Rogoff, 1990; Shleifer and Wolfenzon, 2002). We also document opposite inter-provincial movements of Chinese labor.

To explain both flows of labor and capital in a single framework, we develop an economic geography model of 30 Chinese provinces that introduces financial friction between state and private firms in the style of Antràs and Caballero (2009) (henceforth, AC). We define financial friction as factors that limit capital market integration. With financial friction, there is dispersion in the price (rental rate) of capital among otherwise similar capital users. The dispersion in marginal revenue product of capital (MRPK) leads to misallocation in the sense of Hsieh and Klenow (2009).

Our simple theory model explains why a region's internal financial friction raises the price of capital and hence attracts capital from other regions. At the same time, the internal financial friction lowers the wage and the region experiences outflows of labor.

Intuitively, worsening financial friction suppresses the regional wage due to the misallocation in capital. Falling wage, in turn, can lead to expanding market size effect for exporting firms in the region, yielding greater derived demand for capital, and it bids up the price of capital. The upshot is that worse financial friction lowers the regional wage and raises the price of capital – this triggers outflows of labor and inflows of capital.

Empirically, we carry out both reduced-form and structural exercises to fully confront our model with data. Reduced-form regressions are used to test the model's prediction on the flows of capital and labor at the provincial level. We find robust consistency between data and our model predictions. We then estimate the parameters of the model to minimize the distance between the model and the data around year 2010 and simulate

[1] Papers in this literature includes but are not limited to: Dollar and Wei (2007), Brandt et al. (2013), Lai et al. (2013), Wang (2016), Wu (2018), and Zhang et al. (2019)

counterfactual outcomes that rid of financial frictions. We find that removing financial frictions in China would generate moderate income gains (up to 4% or real income) with widely heterogeneous effects at the provincial level.

We add to the growing evidence since at least Boyreau-Debray and Wei (2005) that financial frictions in China have had far-reaching impact. Boyreau-Debray and Wei (2005) follow Feldstein and Horioka (1980)'s approach and conclude that inter-provincial capital flows in China in 1980s are less mobile than international capital markets between developed countries. Li (2010) confirms Boyreau-Debray and Wei (2005)'s findings to the early 21st century, which overlaps with the period studied in this paper.

Song et al. (2011) famously argue that Chinese domestic private firms' disadvantage relative to the state firms in financial markets is crucial in explaining the coexistence of China's rapid economic growth and net capital outflow from 1992 to 2007. Poncet et al. (2010) provides micro-level evidence that private Chinese firms are credit constrained relative to state-owned firms from 1998 to 2005.

Our paper also relates to the growing literature applying the quantitative trade model at the national level (Donaldson, 2010).[2] Recently, Tombe and Zhu (2018) develop an economic geography model for China and study the impact of migration on welfare. Fan (2019) develops a model with migration at the city level and labor-type differences. Our focus on financial friction across ownership types and provinces in China differentiates our approach from conventional economic geography models by introducing AC-type financial friction between state and private firms.

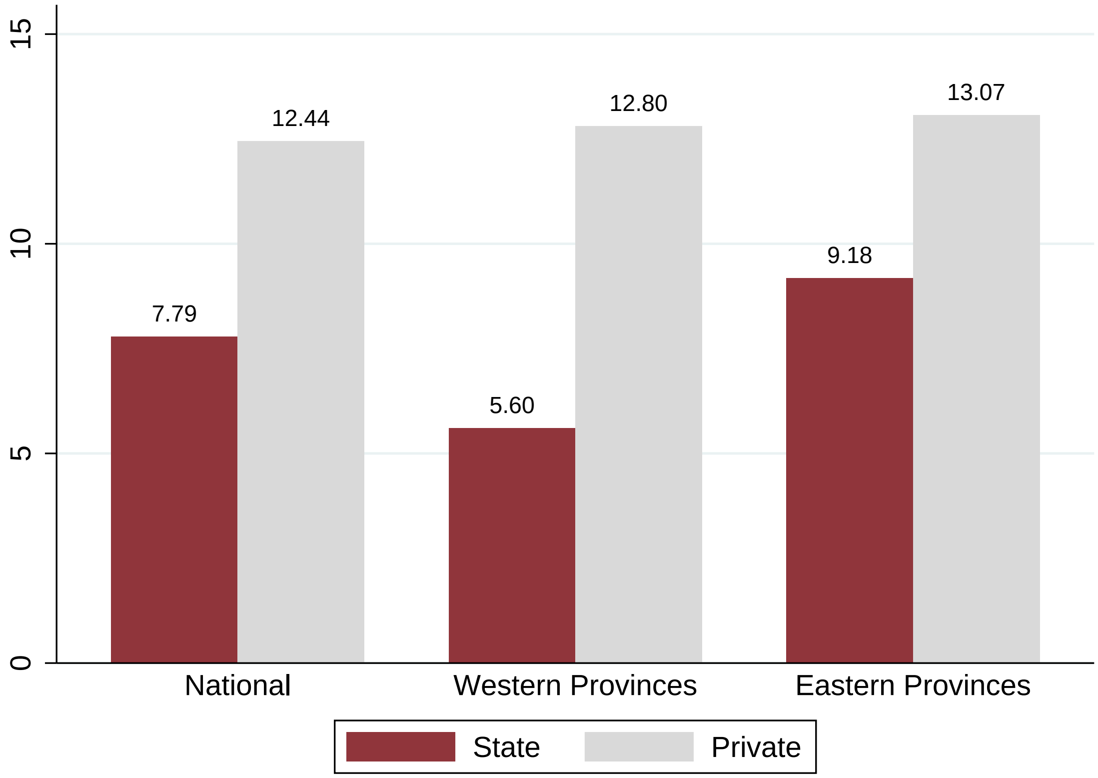
The remaining sections are organized as follows. Section 2 provides some data patterns regarding labor and capital movements in China; section 3 presents our benchmark model which features financial friction for private firms; section 4 describes our data and how we identify financial friction from the data; section 5 presents the reduced-form evidence that our model prediction is consistent with the data; section 6 demonstrates our structural approach to exploit our model and the last section concludes.

2 Labor and Capital Flows in China

Before describing the model, we present key data patterns that motivate our study. Broadly speaking, we find that inter-provincial capital (labor) flows are toward provinces where financial frictions between state and private firms are higher (lower). This finding is robust even when we use different measures of financial frictions, capital flows or migration.

[2]See Costinot and Rodríguez-Clare (2014) for a comprehensive review of the subject.

Figure 1: Average Revenue-Capital Ratios by Firm Ownership Types



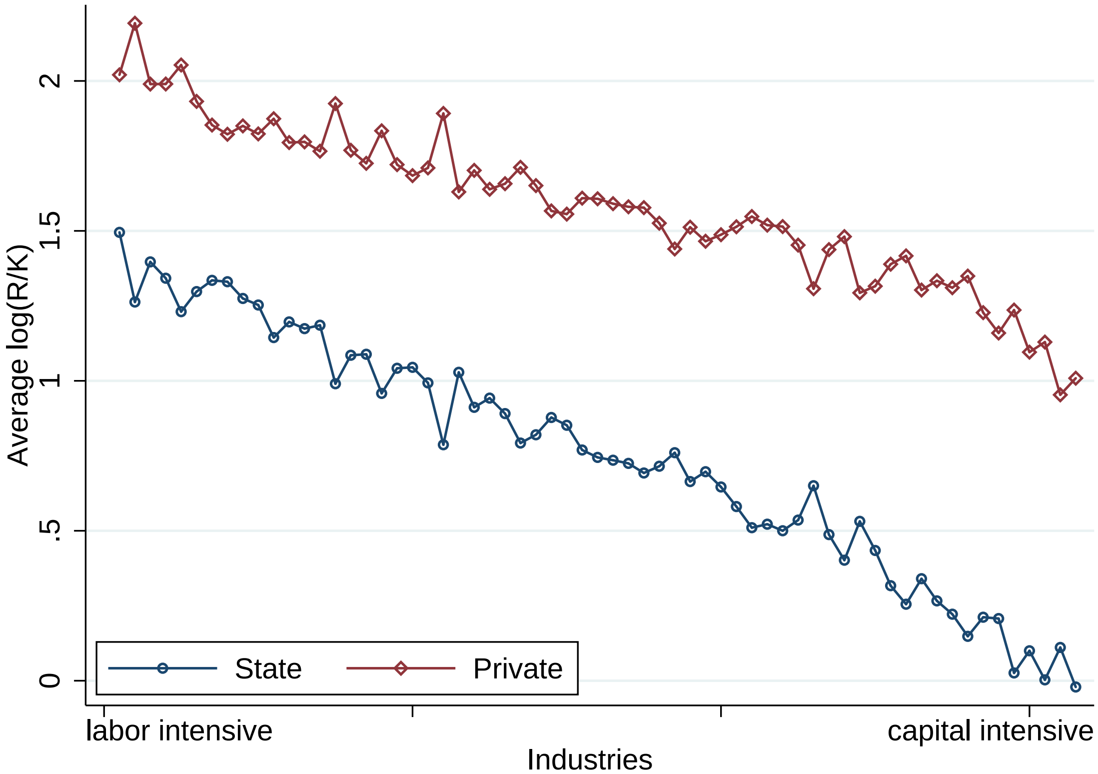
Data: Chinese Industrial Survey, 1998 - 2011 and authors' calculations.

Figure 1 provides first-pass evidence that there is massive capital misallocation in China between private firms and state firms. Nationally, private firms' revenue-to-capital ratios are 60% higher than their state counterparts on average. Roughly speaking, this gap measures the excess capital that state firms employ to generate the same revenue as private firms. Under a Cobb-Douglas production function, the difference in revenue-to-capital ratios is in proportional to the difference in the cost of capital. As we establish later, the private and state firms' difference in revenue-to-capital ratios is an approximate measure of financial friction faced by private firms.

The second and third bars in Figure 1 portray the geographical variation in financial friction faced by private firms. The difference in revenue-to-capital ratios is more pronounced in the western provinces, suggesting more severe financial friction faced by private firms there. This relative financial-market disadvantage in the west is consistent with the restructuring and opening up process in China that began in eastern provinces (Boyreau-Debray and Wei, 2005).

The pattern in Figure 1 can be mechanically driven by state firms' concentration in

Figure 2: Average Revenue:Capital Ratios by Firm Ownership Types across Industries



Notes:

(i) Data: Chinese Industrial Survey, 1998 - 2011 and authors' calculations.
(ii) Average $\log(R/K)$ = average log(revenue/physical capital) in industry groups.

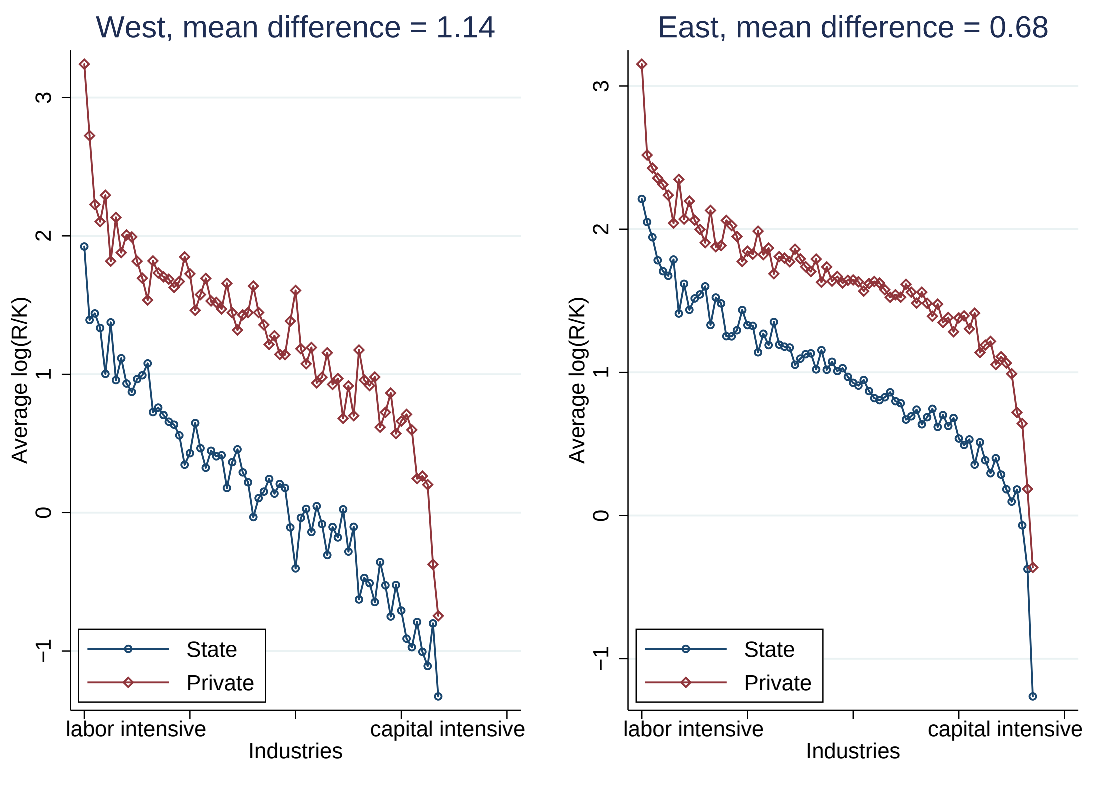
capital-intensive industries. As such, we control for the industry-specific factors by comparing the revenue-to-capital ratios of private and state firms in narrowly defined industry groups (4-digit) in Figure 2. Throughout the industry spectrum, state firms have lower revenue-to-capital ratios than private firms.[3]

In Figure 3, a similar pattern still arises when we reproduce Figure 2 separately for firms located in western and eastern provinces.[4] In both regions, state firms exhibit lower revenue-to-capital ratios than private counterparts. As mentioned earlier, the difference is more pronounced in the west (1.14) than in the east (0.68). We take Figures 1, 2 and 3 as preliminary evidence that private firms in China face disadvantages in the capital market

[3]The comparison within narrowly defined industry groups control for all factors that are specific to industries but common across ownership types.

[4]Eastern: Beijing, Tianjin, Hebei, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, and Hainan; Central: Shanxi, Anhui, Jiangxi, Henan, Hubei and Hunan; Western: Inner Mongolia, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia and Xinjiang; Northeastern: Liaoning, Jilin and Heilongjiang.

Figure 3: Average Revenue-Capital Ratios by Firm Ownership Types across Industries, West vs. East



Notes:

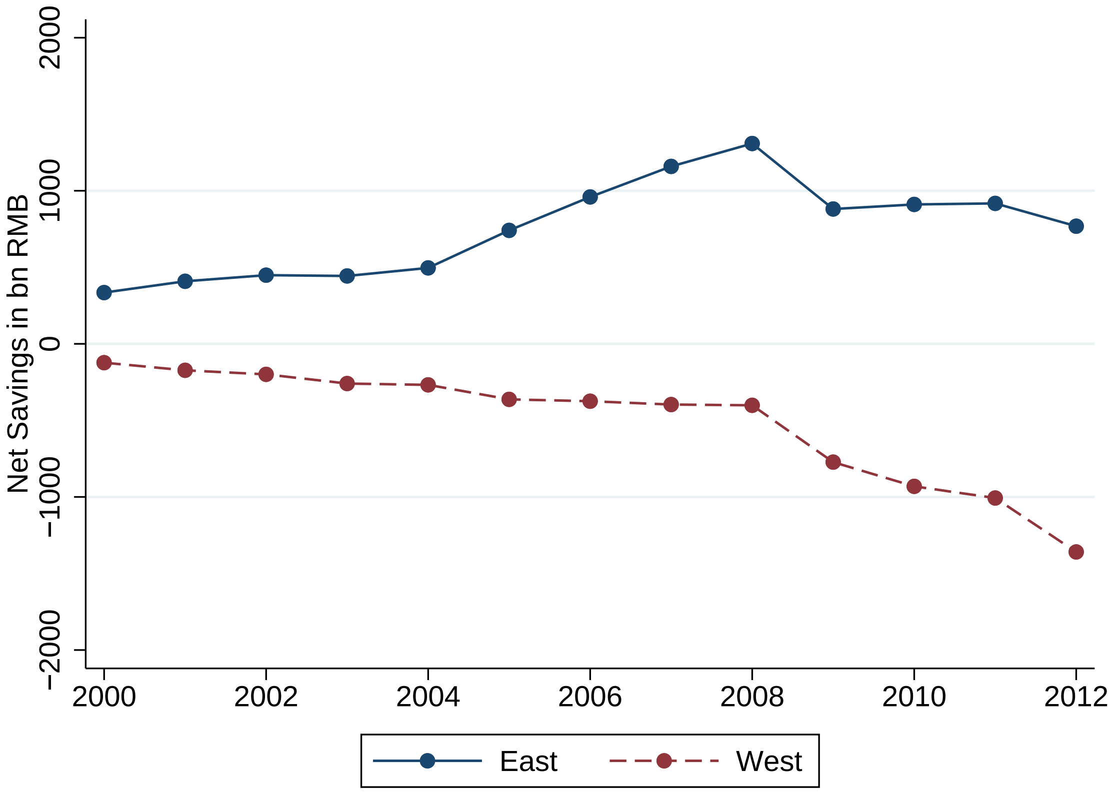
(i) Data: Chinese Industrial Survey, 1998 - 2011 and authors' calculations.
(ii) Average $\log(R/K)$ = average log(revenue/physical capital) in industry groups.

vis-à-vis state firms, especially in western provinces.

We then examine the direction of inter-provincial capital flows across provinces in China. In Figure 4, we see that the approximate measure of a region's net capital outflows, net savings (gross saving less gross investment), indicates that over time there is net movement of capital from east to west. Another approach to estimate the direction of capital flows is to exploit the relation that net exports (roughly) equal net capital outflows. In panel A of Table 1, we use the net export data reported in regional input-output tables to confirm the direction of capital flow to the west.

We also show that inter-provincial movement of labor in China is opposite to that of capital. As shown in panel B and C of Table 1, census data from multiple years jointly confirm the movement of labor to the east. In panel B, migration is defined as movement of population relative to the place of birth and in panel C, migration is defined relative to location 5 years before the survey.

Figure 4: Regional Net Savings, West vs. East



Data: Chinese Statistical Yearbook

To sum up this section, we show that inter-provincial capital flows in China are toward provinces where between-ownership financial friction is *higher* and that the flows of labor are in opposite directions. In the next section, we use our simple theory model to link the movements of both factors to provincial level financial friction.

3 Simple Model of Trade, Migration and Financial Friction

In this section, we present a simple model to show the key mechanism between a region's internal financial friction and factor prices. It features inter-provincial trade of goods, migration and financial friction between state and private firms. We intentionally keep the model simple in this section to manifest the main mechanism. Later, we describe our full-fledged quantitative model where we introduce more technical details to account for different aspects of the data.

Table 1: Regional Capital and Migration Flows

Panel A: Net Capital Outflows			
	(in bn RMB using 2000 as the base year, East $\rightarrow$ West)		
Year	2002	2012	
	82.37	557.93	
Panel B: Net Migration, current location vs. place of birth			
	(in thousands, East $\rightarrow$ West)		
Year	2000 (9.5%)	2010 (10%)	
	-773	-1813	
Panel C: Net Migration, current location vs. location 5 years ago			
	(in thousands, East $\rightarrow$ West)		
Year	2000 (9.5%)	2005 (1%)	2010 (10%)
	-677	-109	-1120

Data: regional input-output table (Panel A); Chinese census data (Panel B and C).

3.1 Trade and Migration

3.1.1 Utility and Demand

Consider an economic geography model that consists of N Chinese provinces. In these provinces, there are two types of capital ownership that we refer with $i \in \{p, s\}$, where p and s respectively stand for private and state-owned capital. The key feature of our model is that firms in the *private* sector face financial friction in the form of credit constraint. (Antràs and Caballero, 2009)

In each region, population is divided into entrepreneurs and workers. Each entrepreneur can produce a distinct variety of goods for consumption. In each region, there are $\{M_{p,n}, M_{s,n}\}$ measures of private (p) and state (s) entrepreneurs. We abstract from entrepreneurs' labor supply and migration decisions as they account for negligible size of the population. The endowment measure of workers in each region are given by L_n who earn labor income and are allowed to move across the provinces.

The representative consumption bundle C_n is expressed in the following CES aggregate of varieties ω:

$$C_n = \left[\sum_{n'} \sum_{i} \int_{\omega \in \Omega_{i,n'}} c_n(\omega)^{\frac{\sigma-1}{\sigma}} d\omega \right]^{\frac{\sigma}{\sigma-1}}, \tag{1}$$

where σ $(\sigma > 1)$ is the elasticity of substitution across the varieties; $\Omega_{i,n'}$ is the set of (distinctive) varieties produced by each type of firm i in region n'; $c_n(\omega)$ represents the quantity of variety ω's consumption in region n. The expression in equation (1) simply means that the consumption bundle in region n entails consumption of varieties from all regions and both ownership types. The measure of varieties produced in each region is equal to the measure of entrepreneurs $|\Omega_{i,n'}| = M_{i,n}$.[5]

Entrepreneur's utility is derived from the consumption bundle. Workers' utility is derived from the consumption bundle and the idiosyncratic regional preferences associated with living in region n:

$$U_n(\epsilon) = b_n(\epsilon) C_n, \tag{2}$$

where $b_n(\epsilon)$ is the location-specific utility shock for worker ϵ. Workers choose where to live in order to maximize their utility based on the regional preference shock, consumption level and the migration costs that we will describe later.[6]

For given income levels, entrepreneurs and workers optimally choose the share of expenditure in each variety to maximize the welfare. The solution to this welfare maximization problem can be studied by the following CES price index P_n:

$$P_n = \left[\sum_{n'} \sum_{i} \int_{\omega \in \Omega_{i,n'}} p_n(\omega)^{1-\sigma} \, d\omega \right]^{\frac{1}{1-\sigma}} \tag{3}$$

where $p_n(\omega)$ is the price of each variety in each region n. Using the CES price index, we can express the residual demand for each variety as:

$$c_n(\omega) = C_n \cdot {P_n}^{\sigma} p_n(\omega)^{-\sigma}$$

3.1.2 Production

On the production side, firms are infinitesimally small and are the monopoly in its own variety. As each entrepreneur produces single distinctive variety, the measure of produced varieties are the same as that of entrepreneurs and are given by $\{M_{p,n}, M_{s,n}\}$. The technology for producing variety ω can be expressed as the following Cobb-Douglas production function:

[5] This follows from our previous assumption that each entrepreneur produces one specific variety and the later assumption that there is no fixed cost of trading across the regions. Our model is akin to Ossa (2014) in the sense that we abstract from the extensive margins of trade. Each region consumes all the varieties from all regions at least by a small amount.

[6] We omit the ϵ index for workers' consumption since all workers in the same region have the same level of consumption.

$$Y_{i,n}(\omega) = z_{i,n} \left(\frac{l_{i,n}(\omega)}{1-\beta} \right)^{1-\beta} \left(\frac{k_{i,n}(\omega)}{\beta} \right)^{\beta}$$

where $z_{i,n}$ is Hicks-neutral productivity that varies by ownership and region; β is the input share of capital and $l_{i,n}$ and $k_{i,n}$ are the amount of labor and capital input. The production function is constant return to scale, meaning that we can express the marginal cost as a function of labor cost (w_n) and capital cost $(r_{i,n})$ as $w_n^{1-\beta} r_{i,n}^{\beta} / z_{i,n}$. We defer our discussion about the determination of wages and rental rates and continue our description of the goods market given w_n and $r_{i,n}$.

Firms also face the marginal trade cost to deliver goods to other regions. Let $d_{nn'} \geq 1$ $(d_{nn} = 1)$ denote the iceberg transport cost from region n to n'. Then the price of good ω produced in region n is priced in region n' as follows:

$$p_{n'}(\omega) = \frac{\sigma}{\sigma - 1} \frac{w_n^{1-\beta} r_{i,n}^{\beta} d_{nn'}}{z_{i,n}} \tag{4}$$

The demand for each variety has negative (own price) elasticity given by σ:

$$Y(\omega) = \sum_{n'} E_{n'} P_{n'}^{\sigma-1} p_{n'}(\omega)^{-\sigma}$$

where $E_{n'}$ denotes total expenditure in region n'.

Summing across all the varieties of goods produced by the ownership type i in region n, the market share of those varieties in region n' can be expressed as:

$$\pi_{i,nn'} = \frac{M_{i,n} \left(w_n^{1-\beta} r_{i,n}^{\beta} d_{nn'} / z_{i,n} \right)^{1-\sigma}}{\sum_n \sum_i M_{i,n} \left(w_n^{1-\beta} r_{i,n}^{\beta} d_{nn'} / z_{i,n} \right)^{1-\sigma}}. \tag{5}$$

Equation (5) is the expression of market shares in the model. Intuitively, taking the denominator of equation (5) (commonly referred to as the multilateral resistance) as given, improved technology by private firms (higher $z_{p,n}$) leads to expansion of market share relative to the state firms as $1 - \sigma < 0$. Similarly, if the trade cost from region n to n' increases, the market share of region n's good in region n' falls.

3.1.3 Factor Market with Financial Friction

Two factors for production are labor and capital. We assume a locally frictionless labor market where there is a single wage w_n for both private firms and state firms in each region.[7] However, financial frictions limit private firms' access to capital relative to those in the state sector. While there are different ways to model financial frictions, we follow Antràs and Caballero (2009) to model financial constraint that arises from private firms' limited access to market for borrowed funds, meaning that private borrowing is limited to no more than a multiple of $(\theta_n - 1)$ of the region's private capital endowment $(\theta_n > 1)$. The parameter θ_n is referred to as *financial contractability* that varies across regions.[8]

To illustrate how θ_n manifests in the model, let K_n denote the total amount of capital in region n, and let μ_n denote the share of capital that is originally owned by private firms.[9] We follow Song et al. (2011) in assuming that private firms have limited access to capital relative to state firms. This means that low θ_n guarantees that the financial contractability constraint is always binding for private firms. In equilibrium, the total amount of $\mu_n \theta_n K_n$ is employed in the private sector and $(1 - \theta_n \mu_n) K_n$ is employed in the state sector.[10] In essence, θ_n functions as a valve that adjusts the relative supply of private and state capital within each region.

Here we stress that private firms in region n can only use the capital from state firms in the same region. As the return to capital is higher in the private firms is higher than that in the state firms, private firms will be always hit by the financial contractability constraint given by θ_n. Our assumption can be understood as a medium-term one where movement of capital is possible (up to some limit) between private and state firms but is not possible between the region.

To formally state our assumption on the financial friction faced by private firms, let $r_{p,n}$ denote the rental rate of capital for private firms and let $r_{s,n}$ denote the rental rate of capital for state firms. Our assumption about θ_n and the financial friction means that $r_{p,n}$ is higher than $r_{s,n}$ in equilibrium.

Assumption 1. *Financial contractability constraint is always binding for private firms. This means that in equilibrium, the rental rate of capital is always higher in private firms.* $(r_{p,n} > r_{s,n})$ *Private firms borrow capital from state firms to the maximum extent that is allowed by the*

[7]We allow for the differential wage between state and private firms.

[8]Our model assumes that capital markets are not integrated across the provinces even for state firms. The lack of inter-regional financial integration has been documented in Boyreau-Debray and Wei (2005) and Qi (2010) among others.

[9]In the static component of the model, we take the state variables $\{K_n, \mu_n\}$ as given. In the static component of Antràs and Caballero (2009), AC uses μ_n to denote the share of entrepreneurs in the population. In the dynamic component, AC shows that the share of capital held by entrepreneurs ($\tilde{\mu_n}$ in their notation) is the key component in equilibrium. In the steady state, $\tilde{\mu}_n$ and μ_n can be different since entrepreneurs and rentiers save differently. Here we use μ_n to denote the share of capital held by private firms.

[10]The assumption that private firms face more restrictive credit constraints than they would in a well-functioning market for funds and relative to state-owned forms has been well documented in in the literature. A notable example is Song et al. (2011) who show that the credit-constraint assumption is critical in explaining net capital outflows from China over the period 1992 to 2007.

contractability constraint. The equilibrium allocation of capital in region n is given by $\mu_n\theta_n K_n$ and $(1-\mu_n\theta_n)K_n$ for private and state firms respectively.

Under assumption 1, we can express the pool of capital used by private firms as $\mu_n\theta_n K_n$, and that used by state firms as $(1-\mu_n\theta_n)K_n$. In a world without financial friction, state capital would flow to private firms as long as $r_{p,n} > r_{s,n}$. The financial contractability assumption essentially limits the total supply of capital to private firms and generates separate capital markets for private and state firms.[11]

Our assumption on the financial friction is to reflect the policy by the Chinese government that the capital usage is always prioritized for state firms (Lin et al., 1994) and that generally credit constraints are used to limit the use of capital (Poncet et al., 2010).

3.1.4 Labor Mobility

To characterize labor mobility across the provinces, we assume that a worker ϵ chooses where to work and live to maximize the utility represented in equation (2) subject to moving cost and idiosyncratic regional shock (b_n) not observed by researchers. We assume that workers' location decisions are made prior to production or consumption decisions and that workers inelastically supply labor for production after migration.

To derive a closed-form solution for the migrant share of a region's population, we impose a structural assumption on the unobservable component of utility that b_n follows Fréchet distribution with parameters $\left\{B_n, \sigma^L\right\}$. The cumulative distribution of b_n is:

$$G_n(b) = e^{-B_n b^{-\sigma^L}}$$

The scale parameter B_n determines average amenity level for location n and σ^L governs the migration elasticity of labor across regions. Using the property of the Fréchet distribution, the share of workers migrating from n' to n can be expressed as:

$$\pi^L_{n'n} = \frac{B_n\left(\frac{w_n}{P_n d^L_{n'n}}\right)^{\sigma^L}}{\sum_n B_n\left(\frac{w_n}{P_n d^L_{n'n}}\right)^{\sigma^L}} \tag{6}$$

Intuitively, equation (6) means that workers from region n' are more likely to migrate region n if the region n provides higher level of average amenities B_n, higher real wages w_n/P_n and lower migration cost $d^L_{n'n}$.

[11]Note that Assumption 1 means that all private firms face the same borrowing rate. The reason is that while financial friction limits the capital allocated to the private sector, it does not limit the flow of capital within the private sector.

3.1.5 Market Clearing

Having specified the goods market, factor market and migration, we characterize the equilibrium of the model. The market clearing condition of private firms' capital is given by:

$$\mu_n \theta_n K_n r_{p,n} = \sum_{n'} E_{n'} \pi_{p,nn'} \beta(\sigma - 1)/\sigma \tag{7}$$

The left-hand side of the equation can be interpreted as the product of private firms' (inelastic) capital supply and the rental rate; and the right-hand side is private firms' demand for capital as a function of expenditure in each region $E_{n'}$, market share in each region $\pi_{p,nn'}$ and the share of return to capital in revenue $\beta(\sigma-1)/\sigma$. Similarly, the market clearing condition for state firms' capital can be expressed as:

$$(1 - \mu_n \theta_n) K_n r_{s,n} = \sum_{n'} E_{n'} \pi_{s,nn'} \beta(\sigma - 1)/\sigma \tag{8}$$

Let L_n denote the measure of labor *after* migration in region n. Each region's total labor is divided between private and state firms:

$$L_n = L_{s,n} + L_{p,n} \tag{9}$$

Wages are the same between private firms and state firms and are given by w_n. The market clearing conditions for labor, akin to those for capital, can be expressed as:

$$L_{p,n} w_n = \sum_{n'} E_{n'} \pi_{p,nn'} (1 - \beta)(\sigma - 1)/\sigma \tag{10}$$

and

$$L_{s,n} w_n = \sum_{n'} E_{n'} \pi_{s,nn'} (1 - \beta)(\sigma - 1)/\sigma \tag{11}$$

Combining the three equations above, the labor market clearing condition in each region can be expressed as:

$$L_n w_n = \sum_{n'} E_{n'} (\pi_{s,nn'} + \pi_{p,nn'})(1 - \beta)(\sigma - 1)/\sigma \tag{12}$$

Let $\bar{L}_n$ denote the labor endowment in region n. The total labor supply in region n is determined by the total labor absorption from all regions:

$$L_n = \sum_{n'} \pi^L_{n'n} \bar{L}_{n'} \tag{13}$$

Finally, total nominal income (or expenditure) in region n consists of labor income, capital income and profit.[12]

$$E_n = w_n L_n + r_{p,n}\mu_n\theta_n K_n + r_{s,n}(1-\mu_n\theta_n)K_n + \sum_i \sum_{n'} E_{n'}\pi_{i,nn'}/\sigma \tag{14}$$

We formally define the equilibrium of our model as follows.

Definition 1. *The equilibrium of the model is defined as* $\left\{w_n, r_{p,n}, r_{s,n}, \pi_{p,nn'}, \pi_{s,nn'}, \pi^L_{n,n}, E_n\right\}$ *determined by equations* (5), (6) *and equation* (7) *through* (14).

3.1.6 Model Comparative Statics

We study the comparative statics of our theoretical model to provide an explanation to the empirical facts described in Section 2. Our model predicts that abatement of financial friction (exogenous increase in θ_n) leads to higher wage and lower rental rate of state capital in the region. Higher wage in turn attracts more workers into the region and lower rental rate of state capital generates a force that triggers capital outflow.

To emphasize the key mechanism of the model, we make a following small-economy assumption to derive Proposition 1. Essentially, the following assumption means that each region is small relative to the rest of China, and thus we can ignore the feedback effect that a marginal improvement in the financial friction generates on its own province through the general equilibrium of all provinces.

Assumption 2. *(**Small Open Economy**) Each province is a small open economy relative to the rest of China. This means that change in the level of local financial contractability θ_n has negligible effect on the equilibrium income and price level in other regions.*

The key function of assumption 2 is that a local change in financial friction θ_n minimally affects other regions' income and price levels and thus the system of equations that involve equations for all regions reduce to that of equations only for region n. Also, as the local expenditure E_n is negligible relative to the rest of China, the local income effect through change in E_n is omitted. Later we discuss the impact on our main results when we relax this assumption. Based on assumption 2, we derive our key proposition about changes in factor prices for different levels of financial contractability.

[12] In our theoretical model, we abstract from central government's transfer or household remittance of income across the provinces. In our econometric specification, however, we use regional dummies to control for transfers of income.

Proposition 1. *Higher θ_n (lower financial friction) leads to higher local wage (w_n) and lower rental rate for private capital ($r_{p,n}$). Namely,*

$$\frac{d\ln w_n}{d\ln\theta_n} > 0,$$

$$\frac{d\ln r_{p,n}}{d\ln\theta_n} < 0,$$

and when $\mu_n\theta_n$ is sufficiently small,

$$\frac{d\ln r_{s,n}}{d\ln\theta_n} < 0$$

Proof. See Appendix B for proof. □

The key mechanism behind proposition 1 is that increase in θ_n allocates the capital from the state to private sector and increases the overall capital efficiency. This provides positive effect on wage through higher marginal product of labor. Increase in wage is passed through to the product price and thus there is negative market size effect for both state and private firms. The negative market size effect reduces the demand for capital and leads to decline in the price of capital.

Our proof of Proposition 1 shows that Assumption 1 (that credit constraint binds for private firms) is a *sufficient and necessary* condition for wages to increase with θ_n. Specifically, Appendix B shows that:

$$\frac{d\ln w_n}{d\ln\theta_n} = \underbrace{\frac{\beta(\sigma-1)}{\sigma}}_{>0}\underbrace{\left[\lambda-(1-\lambda)\frac{\mu_n\theta_n}{1-\mu_n\theta_n}\right]}_{>0 \text{ iff } r_{p,n}>r_{s,n}} \tag{15}$$

where λ $(0<\lambda<1)$ is the share of private firms' output defined as $\lambda = \frac{\sum_{n'} E_{n'}\pi_{p,nn'}}{\sum_i\sum_{n'} E_{n'}\pi_{i,nn'}}$. Equation (15) can be interpreted as that private firms generate positive change in $\frac{d\ln w_n}{d\ln\theta_n}$ through λ and state firms generate negative elasticity change through $(1-\lambda)$. (The strength of the each effect is manifested by the value of λ.) From equations (7) and (8), it is possible to show that the term in the bracket of (15) is positive if and only if $r_{p,n} > r_{s,n}$. Thus, when the financial contractability constraint binds, local wages rise as the local financial friction improves.

Next we explain the impact of θ_n on rental rates. As for the private rental rate $r_{p,n}$, we log-linearize the market clearing condition for the private capital in equation (7):

$$\hat{\theta}_n + \hat{r}_{p,n} = \underbrace{(1-\sigma)(1-\beta)}_{\text{market size effect} < 0}\hat{w}_n + \underbrace{(1-\sigma)\beta}_{\text{market size effect} < 0}\hat{r}_{p,n} \tag{16}$$

where we introduce the notation $\hat{x}$ to represent the log-linearized change in x ($\hat{x} \equiv d\ln x$).

The left-hand side of equation (16) can be interpreted as the change in the supply of private capital measured in value. Namely the log-change in total supply of private capital (in value) is the sum of the log-change in its quantity multiplier $\hat{\theta}_n$, which increases the quantity of private capital, and $\hat{r}_{p,n}$, which is the price of private capital. The demand for private capital, on the right-hand side, decreases with w_n and $r_{p,n}$ as the private firms' joint market share falls.

By observing equation (16), we can observe that θ_n affects $r_{p,n}$ through two channels. The first channel (left-hand side) is simply increasing the supply of private capital with the quantity multiplier θ_n. The second channel (the first term on the right-hand side) is by private firms' negative market size effect coming from higher wages. The feedback effect coming from $r_{p,n}$'s market size effect (the second term on the right-hand side) mitigates this effect but does not reverse the overall sign of θ_n's impact on $r_{p,n}$. Arranging equation (16), we can derive:

$$\hat{r}_{p,n} = \frac{(1-\sigma)(1-\beta)\hat{w}_n - \hat{\theta}_n}{1-(1-\sigma)\beta}$$

From the expression above, it is clear that $r_{p,n}$'s own market size effect is mitigating the overall impact by inflating the denominator by $(1-\sigma)\beta(<0)$. Yet we can determine that the overall sign of $\frac{d\ln r_{p,n}}{d\ln\theta_n}$ is negative.

Similarly, we log-linearlize the market clearing condition for the state capital to derive:

$$-\tilde{\theta}_n\hat{\theta}_n + \hat{r}_{s,n} = \underbrace{(1-\sigma)(1-\beta)}_{\text{market size effect} < 0}\hat{w}_n + \underbrace{(1-\sigma)\beta}_{\text{market size effect} < 0}\hat{r}_{s,n} \tag{17}$$

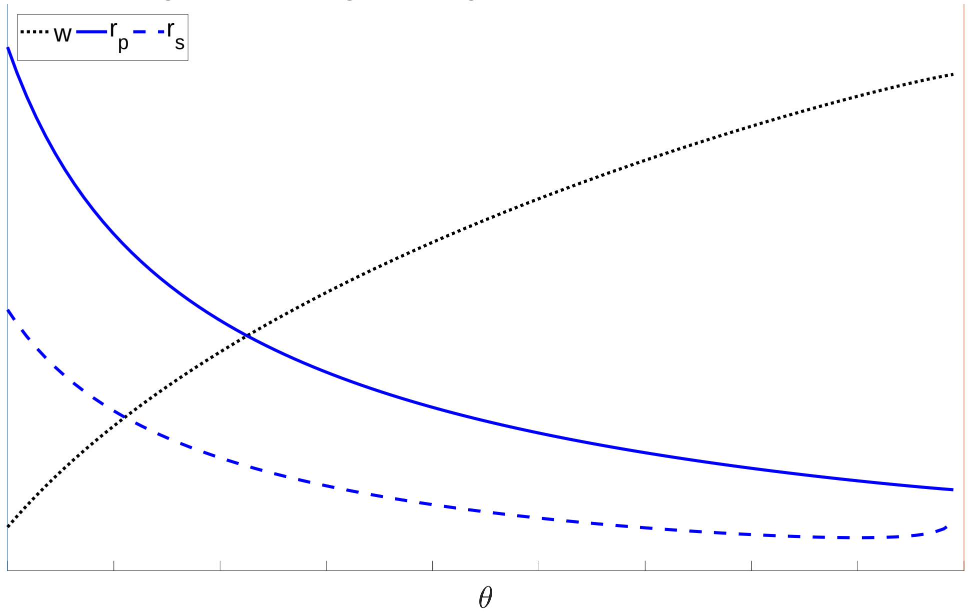
where we define $\tilde{\theta}_n \equiv \frac{\mu\theta_n}{1-\mu\theta_n}$.

We can analyze the equilibrium impact of θ_n using the equation above. From the left hand side, increase in θ_n decreases the supply of capital to the state sector and thus $r_{s,n}$ rises. From the right hand side, however, rise in wage w_n induced by θ_n leads to state firms' negative market size effect and reduces the demand for capital by the elasticity of $(1-\sigma)(1-\beta)$. Analogous to the analysis on $r_{p,n}$, the rise in the rental rate of capital $r_{s,n}$ can generate mitigating impact on the demand for capital by the elasticity of $(1-\sigma)\beta$. After collecting the terms in equation (17), it can be shown that:

$$\hat{r}_{s,n} = \frac{(1-\sigma)(1-\beta)\hat{w}_n + \tilde{\theta}_n\hat{\theta}_n}{1-(1-\sigma)\beta} \tag{18}$$

Unlike $r_{p,n}$, when θ_n rises, the direction of $\hat{r}_{s,n}$ is unclear. The market size effect driven

Figure 5: Change in Wage and Rental Rates with θ



Notes:

(i) This graphs illustrates the change in wage and rental rates with respect to change in θ as illustrated in Proposition 1

(ii) When θ is low (financial friction for private firms is severe), improving financial friction raises the wage and lowers the rental rates for both private and state firms.

by $\hat{w}_n$ is negative, placing a pressure to lower $r_{s,n}$; on the other hand, increase in θ_n reduces the supply of state capital and thus increases $r_{s,n}$. The key to determine the sign is the elasticity of w_n with respect to θ_n. If $\frac{d \ln w_n}{d \ln \theta_n}$ is great, the term $(1-\sigma)(1-\beta)\hat{w}_n$ dominates the term $\tilde{\theta}_n\hat{\theta}_n$ and thus the overall elasticity $\frac{d \ln r_{s,n}}{d \ln \theta_n}$ is negative; otherwise, if the term $\tilde{\theta}_n\hat{\theta}_n$ dominates, the overall elasticity $\frac{d \ln r_{s,n}}{d \ln \theta_n}$ is positive.

To understand the relative strength of $\frac{d \ln w_n}{d \ln \theta_n}$ and $\tilde{\theta}_n\hat{\theta}_n$, notice that in equation (15), when θ_n is close to zero, the elasticity of w_n with respect to θ_n reaches the maximum at $\beta(\sigma-1)\lambda/\sigma$. At the same time, when θ_n is close to zero, the term $\tilde{\theta}_n(\equiv \frac{\mu\theta_n}{1-\mu\theta_n})$ is also close to zero. Hence we can determine that when θ_n is low, the overall elasticity of $r_{s,n}$ with respect to θ_n is negative in equation (18).

Figure 5 illustrates how wage and rental rates change with the change in θ_n. When the financial friction for private firms improves, w_n rises and $r_{p,n}$ falls unambiguously, whereas the change in $r_{s,n}$ is non-monotonic. However, starting from a low level of θ_n, change in $r_{s,n}$ is also negative.

Following corollary links the interprovincial movement of capital and labor with the predicted change in factor prices in Proposition 1.

Corollary 1. *Improved financial contractability increases immigration of workers. When the initial level of contractability is low and the movement of capital is allowed, improved financial contractability increases capital outflows.*

Corollary 1 is a natural implication from our Proposition 1. If a region improves its financial friction, its wage rises and attracts more workers; on the other hand, its rental rates fall and experiences capital outflows. Our assumption on the migration pattern implies that a region will absorb higher share of migration if the local wage increases. In specific, the migration equation (6) can be written as:

$$\ln \pi^L_{n'n} = \sigma^L \ln(w_n) - \sigma^L \ln d^L_{n'n} + D_n + \tilde{D}_{n'} \tag{19}$$

where D_n and $\tilde{D}_{n'}$ are the dummy variable for region n and n'. As we have established that regional wage is increasing with respect to the level of local financial contractability (decreasing with financial friction), equation (19) predicts negative relation between the share of migration to region n and its level of financial friction when other variables are controlled.

Our benchmark model is a static one that does not explicitly generate capital flows. (i.e. we do not have a capital "migration" equation analogous to equation (6).) Yet our model is sufficient to generate variation in capital prices across regions with varying degree of θ_n. In specific, our theory predicts that improvement in financial friction lowers the rental rates of capital in both state and private firms. Thus it is natural to predict that once capital movement is allowed (in a fully dynamic model where inter-regional savings and lendings are allowed) across regions, there will be inter-provincial movement of capital driven by arbitrage. Namely, capital will move out from regions with lower financial frictions.[13]

Corollary 1 is consistent with the broad data pattern we showed in section 2. In our empirical section, we provide rigorous empirical evidence at the provincial and province-pair level. To this end, we need a measure of financial friction which we develop next.

3.1.7 Measure of Financial Friction

Our model guides our empirical approach to measure the degree of financial friction from the data. We manipulate equations (7) and (8) to derive:

[13] Further exploration of our model predicts that when the financial contractability improves in region n, there is a pecking order of capital outflows. Since the state capital is cheaper than private capital, state capital will move first to other regions. As long as there is still positive amount of state capital, the private capital's financial contractability constraint always binds and the amount of private capital in region n is always capped above from $\mu_n \theta_n K_n$.

$$\frac{\mu_n\theta_n}{1-\mu_n\theta_n} = \left(\frac{r_{p,n}}{r_{s,n}}\right)^{-1} \cdot \frac{M_{p,n} z_{p,n}^{\sigma-1}\left(w_n^{1-\beta} r_{p,n}^{\beta}\right)^{1-\sigma}}{M_{s,n} z_{s,n}^{\sigma-1}\left(w_n^{1-\beta} r_{s,n}^{\beta}\right)^{1-\sigma}} = \left(\frac{r_{p,n}}{r_{s,n}}\right)^{-1} \cdot \frac{R_{p,n}}{R_{s,n}} \tag{20}$$

where $\frac{R_{p,n}}{R_{s,n}} \equiv \frac{M_{p,n} z_{p,n}^{\sigma-1}\left(w_n^{1-\beta} r_{p,n}^{\beta}\right)^{1-\sigma}}{M_{s,n} z_{s,n}^{\sigma-1}\left(w_n^{1-\beta} r_{s,n}^{\beta}\right)^{1-\sigma}} = \frac{\sum_{n'} \pi_{p,nn'}}{\sum_{n'} \pi_{s,nn'}}$ is the market share ratio of private firms and state firms.

In our empirical exercise, we use the difference in the (natural logarithm of) marginal revenue product capital of private firms and that of the state owned enterprises, which is the data analogue of $\ln(r_{p,n}) - \ln(r_{s,n})$, along with the market shares of private and state firms to capture the regional level of financial friction. We summarize this in the following proposition.

Proposition 2. *The level of financial friction in a province can be measured by the difference in difference of private and state firms' cost of capital and their revenues. Specifically, we define our measure of financial friction as a strictly decreasing function of θ_n as follows:*

$$FF_n(\theta_n) \equiv \underbrace{\ln\left(\frac{1-\mu_n\theta_n}{\mu_n\theta_n}\right)}_{relative\ \ supply} = \underbrace{[\ln(r_{p,n}) - \ln(r_{s,n})]}_{price\ \ dispersion} - \underbrace{[\ln(R_{p,n}) - \ln(R_{s,n})]}_{relative\ demand} \tag{21}$$

Notice that our measure of financial friction $FF_n(\theta_n)$ is defined to be a strictly decreasing function of θ_n

Proposition 2 defines our measure of regional financial friction between state and private firms as a decreasing function of θ_n. This is consistent with our definition of contractability as lower θ_n aggravates the level of financial friction between the ownership types of firms. Proposition 2 also lays out our empirical approach to measure regional financial friction in a way that is consistent with the model. Essentially, equation (21) shows that we can measure the financial friction by taking the difference in difference of private and state firms' prices of capital and market ratios.

There is an intuitive explanation to the equation (21). The left-hand side is a function of θ_n and it reflects the supply-side distortion between the state and private capital. The first term on the right-hand side $[\ln(r_{p,n}) - \ln(r_{s,n})]$ is the equilibrium price dispersion between the state and private capital. The second term, $[\ln(R_{p,n}) - \ln(R_{s,n})]$, the relative market share of private and state firms, reflects the relative demand for capital. In sum, equation (21) reflects the simple idea that the relative price dispersion is determined by the relative supply and demand.[14]

[14]Our empirical analogue of $\frac{R_{p,n}}{R_{s,n}}$ is the total revenue ratio of private and state firms in region n.

Proposition 2 also provides the theoretical justification for our illustration in section 2 where we use the implied gap between the price of capital between private and state firms as a proxy for underlying financial friction in the region. As equation (21) shows, the gap between private and state's cost of capital $[\ln(r_{p,n}) - \ln(r_{s,n})]$ can be a point estimate of degree of financial friction θ_n if we regard the last term as unobserved.

3.2 Discussion

In this section, we discuss the validity of key assumptions in our benchmark model. We explain why they are necessary to explain the interprovincial flows of capital and labor exhibited in China.

3.2.1 Validity of Assumption 1 and 2

As for Assumption 1, we have shown in Section 2 that there is strong evidence that the capital market is distorted in favor of state firms. We study the consequences of this financial friction, and thus it is relevant to assume that private rental rate is higher than the state counterpart in equilibrium. It is not difficult to consider other equilibrium where the credit constraints are binding for a subset of provinces, but it is not the key interest of our paper. Indeed, Assumption 1 is supported from the data (Figure 6).

Assumption 2 is a convenient assumption to eliminate the general equilibrium effects that complicate the mechanism. If we relax assumption 2, there will be two additional general equilibrium effects. The first one is the general equilibrim from other regions, i.e. when overall factor prices from region n increases, other regions decrease their spending on goods from region n due to terms-of-trade effect. We argue that this effect is not central to our analysis since there are a total number of 30 provinces in China and none is big enough to significantly impact other regions' real income by change in its level of financial friction. The second muted general equilibrium effect is the income effect, i.e. when overall factor prices from region n increases, there is positive income effect that increases overall demand. We argue that this income effect is not key to our analysis as we are interested in the dispersion of factor prices in the region in question. Aforementioned two general equilibrium effects tend to generate *shift* in the factor prices in the same direction and not the dispersion among them.

3.2.2 Assumption on the Financial Friction

In our model, we follow Antràs and Caballero (2009) to model financial constraint as credit constraints to the private sector. Namely the total amount of capital used by the private sector faces inelastic supply constraints. An alternative way to model financial friction is to assume a *price wedge* between private and state firms in the style of Hsieh and Klenow (2009). This alternative way of closing the model would imply replacing our equations (7) and (8) with a system of four equations regarding K_n^p, K_n^s, $r_{p,n}$ and $r_{s,n}$:

$$K_n^p r_{p,n} = \sum_{n'} E_{n'} \pi_{p,nn'} \beta(\sigma - 1)/\sigma$$

$$K_n^s r_{s,n} = \sum_{n'} E_{n'} \pi_{s,nn'} \beta(\sigma - 1)/\sigma$$

$$r_{p,n} = r_{s,n} \tau_n$$

$$K_n = K_n^s + K_n^p$$

The first two equations are the market clearing conditions for state and private capital respectively, the third equation means that there is a positive price wedge $\tau_n > 1$ between the state and private capital and the fourth equation means that all capital in region n is used either in private or state sector.

3.2.3 Assumption on the Capital Immobility in the Short Run

Our benchmark model is a short-run model where labor is mobile across the regions but capital is fixed to each region. The short-run regional dispersion in capital prices leads to the inter-provincial movement of capital in the long run.

Our assumption on the (lack of) regional capital mobility is supported by previous literature on Chinese capital market that there is huge regional friction across Chinese capital markets. Notably, Wang (2016) finds that the Feldstein and Horioka (1980) test on Chinese provinces from 1994 to 2010, which encompasses our sample periods, is over 0.64 after accounting for the spatial autocorrelation. The author concludes that, "the provincial capital mobility of China is surprisingly weak during this period."

Potentially there can be multiple reasons why there is lack of capital mobility across the Chinese provinces. Boyreau-Debray and Wei (2005) argues that inter-provincial capital flows in China are driven by the central government's policy to favor the use of capital in some regions. Li (2010) suggests that lack of financial integration in China is due to local protectionism.

4 Data and Measure of Financial Friction

4.1 Data

We use China's Industrial Survey data, collected by the National Bureau of Statistics of China, to estimate financial frictions for the period 1998-2011. The survey data cover all industrial firms in China with sales revenue greater than 5 million RMB. There are about 1 million firms in the original dataset. Three key variables we use to estimate financial frictions are operating profit, operating revenue, and real capital stock constructed by the perpetual inventory method. Similar to Song and Wu (2015), we deflate profit and revenue data using the GDP deflator for the secondary industry. Firms' ownership categories are defined according to their official registration (Song and Wu (2015); Brandt et al. (2017)). Observations with negative profit-to-revenue ratio or missing provincial information are excluded in our analysis. Firms that belong to the mining or utility sectors are dropped. In addition, we adopt a similar strategy used in Song and Wu (2015) to remove outliers by trimming the top and bottom 5% of each variable in each province-year pair. Our final sample consists of 678845 firms.

We use the net export data to measure net capital outflow. There are two different sources of data we use to measure net export. The first one comes from expenditure categories of GDP. The data are obtained from the CEIC database, which allows us to compute the differences between saving and investment at the provincial level.[15] The second one comes from inter-provincial input-output tables for 2002 (Shi and Zhang, 2012) and 2012 (Mi et al., 2017), covering bilateral trade flows in agricultural, industrial and service goods. Our first net export measure focuses on the net capital outflow of a province while the second one focuses on the net capital outflow between paired provinces. We also use inter-provincial input-output tables to obtain the required gross fixed capital formation data (GFCF).

Inter-provincial labor migration data are obtained from the 2000 and 2010 Population Census. It provides us a transition matrix between the place of birth and current location. The transfer payment data between the central and local governments are obtained from the CEIC database.

[15] https://www.ceicdata.com

4.2 Measure of Financial Friction

Our model implies that financial friction is reflected in the difference in difference in marginal revenue product of capital (MRPK) and market shares across ownership types of firms. We use Chinese firm-level data to measure MRPK. The procedure is similar to Wu (2018), but is modified to our model. (See Appendix A for the discussion of our approach and Wu (2018)'s approach.) Here we review our key assumptions and the estimating equation.

In our model, monopolistically competitive firms set their profit-maximizing price independent of other firms, the revenue generating function for each firm can be expressed as follows:

$$R_{it} = \Gamma_{it} \left(K_{it}^{\beta_i} L_{it}^{1-\beta_i} \right)^{1-\frac{1}{\sigma_i}} \tag{22}$$

where subscript i is for each firm and t is for year, and Γ_{it} is a firm-specific demand shifter. Our specification allows demand elasticity σ_i and capital share β_i to vary across different industries. Equation (22) can be written as:

$$\ln(MRPK_{it}) \equiv \frac{\partial R_{it}}{\partial K_{it}} = \ln(ARPK_{it}) + \ln(\beta_i(1 - 1/\sigma_i)) \tag{23}$$

where the term $ARPK_{it}$ (average revenue product of capital) is simply defined as $ARPK_{it} \equiv R_{it}/K_{it}$. Applying a Taylor extension on the last term around $1 - 1/\sigma_i$ with slight manipulation we derive our following estimating equation,

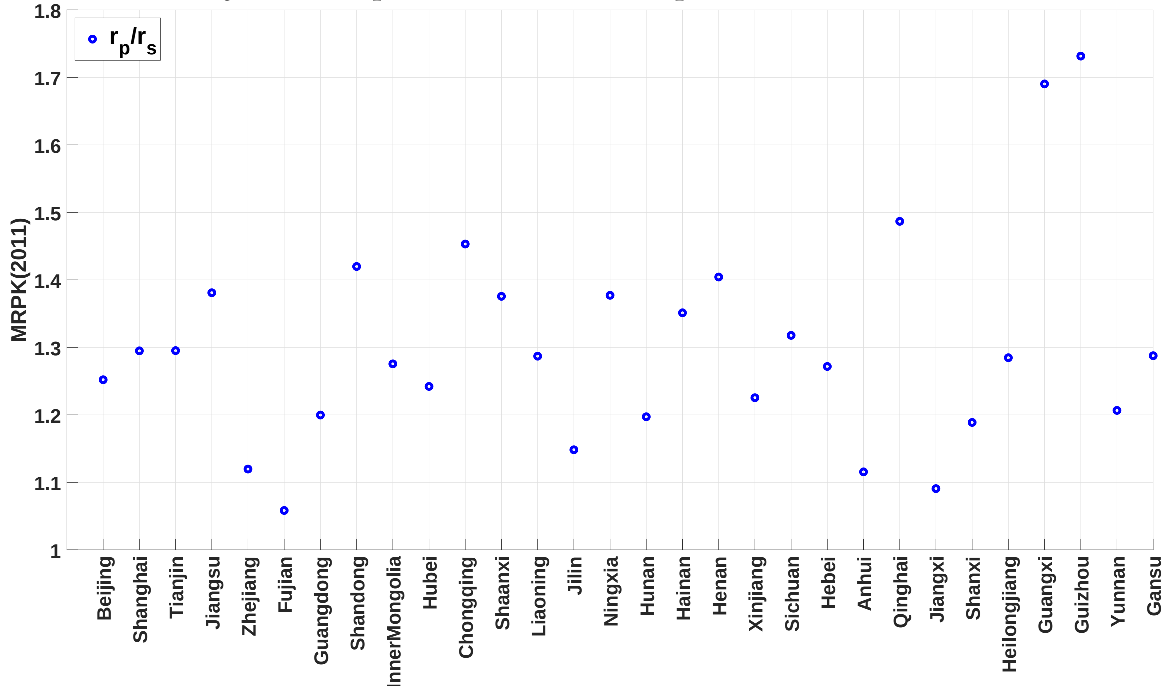
$$\ln(ARPK_{it}) = \gamma_0 + \gamma_{1t} \ln \left(1 - \frac{\Pi_{it}}{R_{it}} \right) + Ind_{it} + \ln(MRPK_{it}) \tag{24}$$

where Π_{it} and R_{it} are the profit and revenue of firm i in year t and Ind_{it} is industry-year fixed effect. Note that in equation (24), every term is observed from data except the last term $\ln(MRPK_{it})$. We use the estimated error term as the estimate of $\ln(MRPK_{it})$. Namely,

$$\ln(M\hat{R}PK_{it}) = \ln(ARPK_{it}) - \hat{\gamma}_0 + \hat{\gamma}_{1t} \ln \left(1 - \frac{\Pi_{it}}{R_{it}} \right) + I\hat{n}d_{it} \tag{25}$$

We then calculate the average of $\ln(M\hat{R}PK_{it})$ by province, year and ownership to construct $\ln(r_{s,n}) - \ln(r_{p,n})$ for each year, relying on the firms' first order condition that $r = MRPK$. Next we use the firm level data to calculate the sales ratio of revenue by province, year and ownership ($R_{p,n}/R_{s,n}$). These are combined to calculate our measure of financial friction according to equation (21).

Figure 6: Dispersion in Price of Capital across Provinces



Notes:

(i) Source: Chinese MLE data and authors' calculation based on equation (25).

(ii) Provinces are in the order of provincial GDP per capita.

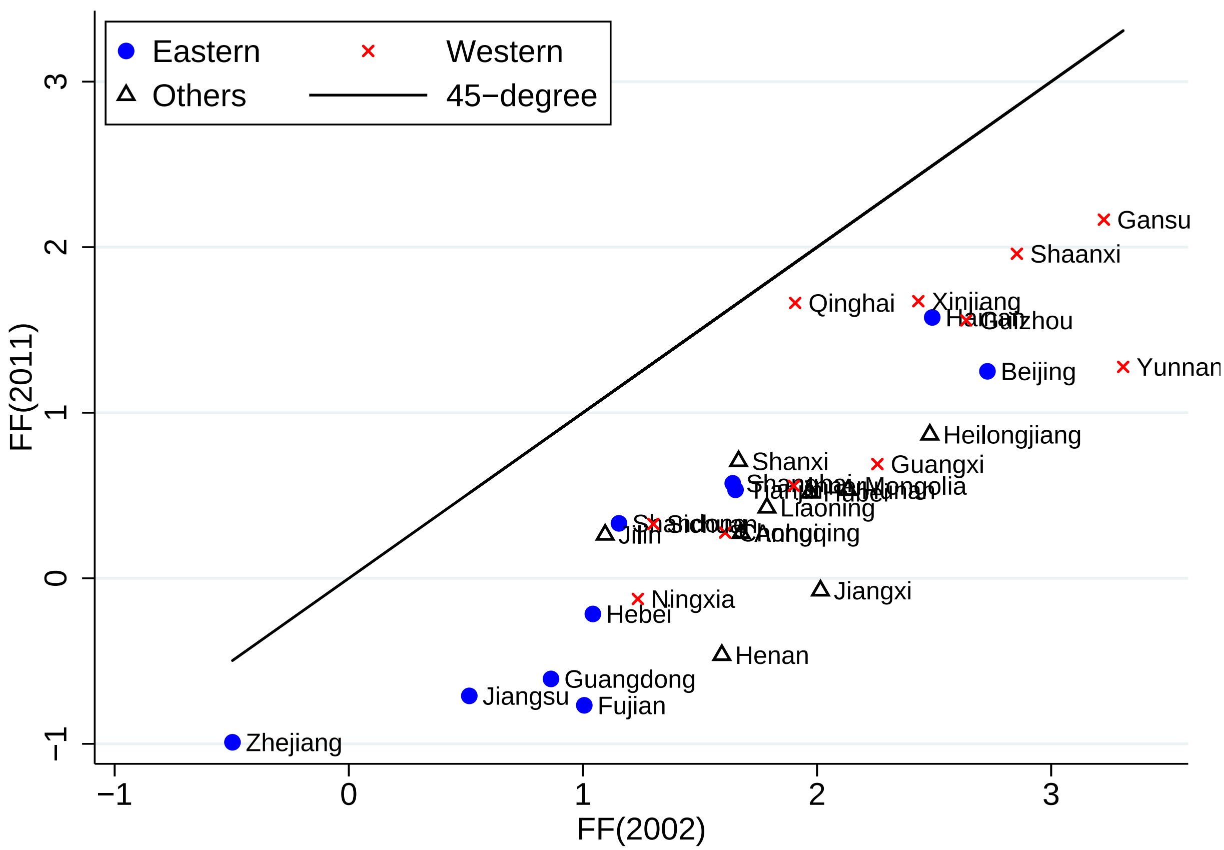
To be specific, our empirical analogue of equation (21) is:

$$\hat{FF}_n \equiv \underbrace{[\ln(\hat{r}_{p,n}) - \ln(\hat{r}_{s,n})]}_{\text{estimated with equation (25)}} - \underbrace{[\ln(R_{p,n}) - \ln(R_{s,n})]}_{\text{market share measured from data}} \tag{26}$$

Figure 6shows the estimated ratio of private and state rental rates of capital. Notice that the ratios of r_p/r_s are above 1 across all provinces. Less developed provinces (provinces on the right end of the spectrum) tend to have higher gap between the price of capital. We take Figure 6 as strong evidence against integrated financial market between state and private firms.

Figure 7 shows the change in the level of financial friction in China from the year 2002 to year 2011. Two patterns are noteworthy. First, all provinces have lower financial friction in 2011 compared with that in 2002. Second, western provinces (in red) consistently have higher financial friction compared with eastern provinces (in blue) and other provinces (in black). This is consistent with our evidence in Section 2 that Western provinces exhibit higher financial friction for private firms.

Figure 7: Financial Friction Comparison (2002 vs. 2011)



Notes:

(i) Source: Chinese MLE data and authors' calculation based on equation (26).

(ii) See footnote 4 for regional classification of provinces.

5 Regression Evidence

In this section, we use our measure of regional financial friction developed earlier to test our model predictions regarding labor and capital flows between Chinese provinces.

5.1 Capital Flows

Chinese inter-provincial capital flow data (analogous to foreign direct investment) are not directly observable. Hence we use net export of goods and services from provincial input-output tables to proxy net capital outflows between Chinese provinces. The first set of regressions explore the relationship between net export and the cross-province difference in the level of financial friction. We introduce additional control variables to account for other variables potentially missing in our model. Our regression specification is:

$$\ln(NX_{nn't}) = \gamma_1(FF_{n',t-1} - FF_{n,t-1}) + \gamma_2 \ln(d_{nn'}) + \gamma_3(NT_{n',t-1} - NT_{n,t-1}) + \phi_t + D_n + \tilde{D}_{n'} + \epsilon_{nn't} \quad (27)$$

where $NX_{nn'}$ is the net export of goods and services from province n to n'; t indexes for the year; FF_n is the measure of financial friction in province n; $d_{nn'}$ is the distance between province n and n'; NT_n is the net transfers from the central government to province n relative to its GDP; ϕ_t denotes year fixed effects; D_n and $\tilde{D}_{n'}$ capture the origin and destination province fixed effects, respectively. The origin province n is chosen to ensure that $NX_{nn'}$ is positive.

The regression results of model (27) are reported in Table 3. As shown in column (1), the coefficient of the difference in FF is positive and significant, consistent with our theoretical prediction. The coefficient of the distance variable is also significant with the expected sign. For a robustness check, we re-compute FF and NT using their lagged 3-year moving averages, and the regression results reported in column (2) shows that our conclusion remains unchanged.

In addition, we replace NX with the net export into final expenditures on gross fixed capital formation (denoted by $Net\ GFCF$) in model (27). The additional regression results are reported in columns (3) and (4) of Table 3. Again, the coefficients of the distance variable and the difference in FF are significant with signs as hypothesized. All of these estimates hold paired government transfers constant, so we may infer that they reflect the decisions of private investors deciding where to place their funds to yield the highest returns.

Next, we turn to our province-level regression specified as follows:

$$NX_{nt} = \lambda_1 FF_{n,t-1} + \lambda_2 NT_{n,t-1} + \phi_t + \epsilon_{nt} \tag{28}$$

where NX_n is the net export of goods and services from province n to the rest of the world, including other provinces in China. It is important to note that we do not include the province fixed effect in model (28) because our theoretical framework has no prediction on the relationship between NX and FF within a province. Instead, we examine the average impact of FF on NX given a time period (by controlling for the year fixed effect).

In Table 4 we report regression results based on provincial aggregate panel data. Estimated regression coefficients of FF are consistently negative as hypothesized. Provinces with a lower level of financial friction experience higher net capital outflow. Results from Tables 3 and 4 confirm our Corollary 1.

5.2 Wage and Migration

Our theoretical framework predicts that worsening financial friction tends to decrease the average wage and increase outflow of labor. We first examine how financial friction affects the average wage using the regression model below:

$$\begin{aligned} \ln(W_{n't}) - \ln(W_{nt}) = \; & \gamma_1(FF_{n',t-1} - FF_{n,t-1}) + \gamma_2 \ln(d_{nn'}) + \gamma_3(NT_{n',t-1} - NT_{n,t-1}) \\ & + \phi_t + D_n + \tilde{D}_{n'} + \epsilon_{nn't} \end{aligned} \tag{29}$$

where W_n denotes the average urban wage in province n.[16] The model specification is the same as model (27) except that the dependent variable is replaced by the log difference in the average urban wage between two provinces. The regression results are reported in Column (1) of Table 5, and Column (2) reports the results for the FF and NT variables constructed using the lagged 3-year moving averages. Both sets of the regression results consistently yield the negative and significant coefficient, with the sign as hypothesized for the difference in financial friction between two provinces.

Finally, we explore the relationship between migration and the level of destination financial friction specified as follows.

[16] According to the 2019 China Statistical Yearbook, average wages of employed persons in urban units from 1995 to 2008 refer to average earnings of employed persons in urban non-private units. We follow this practice to construct the average urban wage. After 2008, the wage data from both urban private and non-private units became available, and we use them to compute the average urban wage weighted by their national employment shares.

Table 2: Summary Statistics

Variables	Mean	Std.	N
Input Output Tables: Provincial Paired Data			
Absolute (Net Exports)	8.490	15.594	870
Absolute (Net GFCF Exports)	6.207	16.416	870
GDP: Expenditure Approach			
Net Exports	1.859	126.085	434

Notes:

(i) Net Exports and GFCF are in units of 1 billion RMB

(ii) Paired data measure inter-provincial flows across 30 paired provinces (excluding Tibet) for the years 2002 and 2012. Data from provincial input-output tables are provided by Shi and Zhang (2012) and Mi et al. (2017).

(iii) Net GFCF Exports are net exports into final expenditures on gross fixed capital formation, taken from the provincial input-output tables.

(iv) Net Exports from the last row measures the net exports between each province and the rest of the world, including other provinces in China. The data are taken from the CEIC database for the years 1999 - 2012. Net exports are calculated using the expenditure approach based on SNA definitions of GDP = C+I+G+NX.

(v) Sample sizes change depending on which variables we look at. This is because the paired provincial data (n=870) from the IO tables only give us two years of data, but many observations per year. The provincial data (n=434) given us fewer observations per year, but span more years, starting in 1999.

$$\ln \pi^L_{nn't} = \xi_1 FF_{n',t-1} + \xi_2 \ln(d_{nn'}) + \phi_t + D_n + \tilde{D}_{n'} + \epsilon_{nn't} \tag{30}$$

where $pi^L_{nn'}$ is the share of migrant individuals from province n located in province n'. This regression specification is motivated by equation (6). The regression results reported in Column (1) of Table 6 show that the migration share decreases with the level of financial friction at the destination province, which is consistent with our theoretical prediction. Using the lagged 3-year moving averages to construct the FF variable, it does not change our conclusion as shown in Column (2). Provinces with lower financial friction tend ot attract a larger proportion of migrants.

Table 3: Capital Flow Regression Results Using Provincial Paired Data

VARIABLES	(1) Log NX *Lagged one year*	(2) Log NX *Average of the last three years*	(3) Log Net GFCF *Lagged one year*	(4) Log Net GFCF *Average of the last three years*
Diff (FF)	0.267*	0.311***	0.629***	0.615***
	(0.144)	(0.111)	(0.169)	(0.142)
Log Distance	-1.096***	-1.106***	-1.140***	-1.147***
	(0.0895)	(0.0888)	(0.115)	(0.115)
Diff (Net Transfers)	-1.569	-0.941	-0.199	-0.168
	(1.587)	(1.462)	(1.809)	(1.770)
Observations	869	869	864	864
Adjusted R^2	0.608	0.610	0.767	0.769
Origin FE	YES	YES	YES	YES
Destination FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES

Notes:

(i) Estimated robust standard errors are in the parentheses. *** p<0.01, ** p<0.05, * p<0.1.
(ii) Paired data measure inter-provincial flows across 30 paired provinces (excluding Tibet) for the years 2002 and 2012. Data are from provincial input-output tables provided by Shi and Zhang (2012) and Mi et al. (2017).
(iii) In Columns (1) and (2), we only focus on the provinces with NX > 0, while in Columns (3) and (4) we only focus on the provinces with Net GFCF > 0.
(iv) Distance measures the distance between the paired provinces (in km).
(v) Diff (FF) is the difference in FF between the destination and origin provinces.
(vi) Net Transfers are the net transfers from the central government to the local province, relative to its GDP. Diff (Net Transfers) is difference in Net Transfers between the destination and origin provinces.
(vii) Columns (1) and (2) use Diff (FF) and Diff (Net Transfers) lagged by one year, while Columns (3) and (4) use their average values from the last three years.

Table 4: Capital Flow Regression Results Using Provincial Data

VARIABLES	(1) NX *Lagged one year*	(2) NX *Average of the last three years*
FF	-0.472***	-0.605***
	(0.0720)	(0.0872)
Net Transfers	-0.489	-0.283
	(0.397)	(0.396)
Observations	370	371
Adjusted R^2	0.163	0.179
Year FE	YES	YES

Notes:

(i) Estimated robust standard errors are in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.
(ii) The dependent variable is the NX of a province (in 100 bn RMB), obtained from GDP accounts.
(iii) Net Transfers are the net transfers from the central government to the local province, relative to its GDP.

Table 5: Wage Regression Results

VARIABLES	(1) NX *Lagged one year*	(2) NX *Average of the last three years*
FF	-0.273***	-0.362***
	(0.0638)	(0.0784)
Net Transfers	0.0458	0.255
	(0.288)	(0.265)
Observations	370	371
Adjusted R^2	0.327	0.351
Region FE	YES	YES
Year FE	YES	YES

Notes:

(i) Estimated robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
(ii) The Diff variables are computed based on the difference between the destination and origin provinces.

Table 6: Migration Regression Results

VARIABLES	(1) ln(Migration Share) *Lagged one year*	(2) ln(Migration Share) *Average of the last three years*
Destination FF	-0.158***	-0.216***
	(0.0381)	(0.0574)
Log Distance	-1.052***	-1.049***
	(0.0170)	(0.0172)
Observations	1,922	1,891
Adjusted R^2	0.822	0.822
Origin FE	YES	YES
Destination FE	YES	YES
Year FE	YES	YES

Notes:

(i) Estimated robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
(ii) Migration share refers to the share of migrant individuals from the origin province located in a destination province.

6 Quantitative Model

In this section, we expand our benchmark model to a multi-sector version to account for sectoral heterogeneity in the data. This degree of model freedom allows us to capture sectoral heterogeneity in the data when we perform quantitative exercise.

6.1 Multisector

We introduce the superscript j to denote a sector.[17] We introduce the sectoral consumption shares by region α_n^j ($\sum_j \alpha_n^j = 1$) and let elasticity of substitution σ^j, capital share β^j, technology $\{z_{p,n}^j, z_{s,n}^j\}$ and the iceberg trade cost $d_{nn'}^j$ vary by sectors. In the main text, we describe a few key equations for the enriched model and refer readers to Appendix C for full specification of the quantitative model.

The regional consumption is now defined as the Cobb-Douglas product of each sector j's consumption C_n^j:

$$C_n = \prod_j \left(\frac{C_n^j}{\alpha_n^j}\right)^{\alpha_n^j},$$

where α_n^j is the expenditure share in sector j and region n. The corresponding price index in region n becomes:

$$P_n = \prod_j \left(P_n^j\right)^{\alpha_n^j} \tag{31}$$

where P_n^j is the sectoral price index in province n.

We also allow the capital intensity β^j and the elasticity of substitution σ^j to vary across sectors. This means that the pricing of a variety ω selling to region n' can be expressed as

$$p_{n'}(\omega) = \frac{\sigma^j}{\sigma^j - 1} \frac{w_n^{1-\beta^j} r_{i,n}^{\beta^j} d_{nn'}^j}{z_{i,n}^j}$$

where the level of technology $z_{i,n}^j$ can also vary across the sectors and ownership types.

The market share is defined for each sector as follows:

$$\pi_{i,nn'}^j = \frac{M_{i,n}^j \left(w_n^{1-\beta^j} r_{i,n}^{\beta^j} d_{nn'}^j / z_{i,n}^j\right)^{1-\sigma^j}}{\sum_n \sum_i M_{i,n}^j \left(w_n^{1-\beta^j} r_{i,n}^{\beta^j} d_{nn'}^j / z_{i,n}^j\right)^{1-\sigma^j}} \tag{32}$$

[17] We are considering three sectors: agricultural, manufacturing and service.

To close the model, we impose labor market clearing conditions, capital market clearing conditions and regional budget constraints. For brevity, we refer readers to Appendix C for details.

6.2 Prior Parameters from Literature and Data

As there are commonly used value ranges for migration and trade elasticities, we borrow those values respectively from Tombe and Zhu (2018) and Caliendo et al. (2017). Since we do not consider heterogeneous firm distribution, the trade elasticity is simply elasticity of substitution minus one.[18] In our quantitative model, we consider three sectors: Agriculture and Mining, Manufacturing and Service. The elasticities of substitution are respectively given by 8.4, 4.4 and 2.8.

We rely on Holz and Yue (2018) and 2010 census data for values accumulated capital in each province and labor endowment. Expenditure shares by province and sector (α_n^j) are from the 2012 input-output table. Capital shares by sectors are calculated from the 2011 firm-level data.

6.3 Estimated Parameters

6.3.1 Estimating Trade and Migration Cost

Next we follow the approach popularized by Novy (2013) to estimate iceberg trade cost ($d_{nn'}^j$) and migration cost ($d_{nn'}^L$). The idea of Novy (2013) is that if we assume trade costs are symmetric and if we know the values of elasticity parameters, iceberg trade cost and migration cost can be expressed as

$$d_{nn'}^j = d_{n'n}^j = \left(\frac{\sum_i \pi_{i,nn'}^j \sum_i \pi_{i,n'n}^j}{\sum_i \pi_{i,n'n'}^j \sum_i \pi_{i,nn}^j} \right)^{\frac{1}{2(1-\sigma^j)}} \tag{33}$$

and

$$d_{nn'}^L = d_{n'n}^L = \left(\frac{\pi_{nn'}^L \pi_{n'n}^L}{\pi_{n'n'}^L \pi_{nn}^L} \right)^{-\frac{1}{2\sigma^L}} \tag{34}$$

In the data, trade between provinces are not separately reported by ownership, meaning that the term $\pi_{i,nn'}^j$ are not observed in the data. To overcome this problem, we rely on the following relation that is implied by our model:

[18] See Tombe and Zhu (2018) for the discussion of the values of migration elasticity and Caliendo et al. (2017) for the discussion of the values of trade elasticity.

$$\frac{\pi^j_{p,nn'}}{\pi^j_{s,nn'}} = \frac{\tilde{M}^j_{p,n}}{\tilde{M}^j_{s,n}} \cdot \left(\frac{r_{p,n}}{r_{s,n}}\right)^{\beta^j(\sigma^j-1)} = \frac{L^j_{p,n}}{L^j_{s,n}} \tag{35}$$

where we define the efficiency-adjusted measure of firms as $\tilde{M}^j_{i,n} \equiv M^j_{i,n}\left(z^j_{i,n}\right)^{\sigma^j-1}$; $L^j_{i,n}$ $(i = p, s)$ is the size of employment by ownership type i in region n and sector j. The first equality in equation (35) comes from equation (32) and the second equality comes from the following labor demand equation by ownership and sector:

$$L^j_{i,n} = \sum_{n'} E_{n'}\alpha^j_{n'}\pi^j_{i,nn'}(1-\beta^j)(\sigma^j-1)/\sigma^j$$

Given the values of $\pi^j_{i,nn'}$ and $\pi^L_{nn'}$, underlying trade and migration cost can be recovered given the elasticity values in Section 6.2.

6.4 Estimating Efficiency Units of Firms, Regional Amenity and Financial Friction

We jointly estimate $\left\{\tilde{M}^j_{p,n}, B_n, \mu_n\theta_n\right\}$ so that the key equilibrium variables of the model has the minimum sum of squared distance to the data. Note here that our model cannot separately identify μ_n and θ_n since they always appear jointly whenever they appear in the model. However, this does not hinder our model estimation and later counterfactual exercise since we estimate the product of $\mu_n\theta_n$ *altogether* and we consider percentage change in θ_n. We motivate our counterfactual exercise as percentage increment in θ_n, which means that private firms can borrow certain percentage of capital due to improved financial contractability. Yet the same effect can be achieved when μ_n increases by the same percentage point, holding constant θ_n. This observationally equivalent counterfactual exercise can be motivated by the case where private firms increase their own capital reserve holding constant the level of financial contractability.

We formally describe our strategies to estimate those parameters before we discuss how the parameters are identified in the model. We estimate $\left\{\hat{\tilde{M}}^j_{p,n}, \hat{B}_n, \widehat{\mu_n\theta_n}\right\}$ to minimized the sum of distance of labor retention share, trade share and dispersion in rental rates. Specifically we let our estimators be the numerical minimizer of the following expression:

$$\left\{\hat{\hat{M}}^j_{p,n}, \hat{B}_n, \hat{\mu_n \theta_n}\right\} \equiv \text{argmin} \sum_j \sum_n \sum_{n'} \left(\hat{X}^j_n - X^j_n\right)^2 + \sum_n \left(\hat{\pi}^L_{nn} - \pi^L_{nn}\right)^2 + \sum_n \left(\frac{\hat{r}_{p,n}}{\hat{r}_{s,n}} - \frac{r_{p,n}}{r_{s,n}}\right)^2 \tag{36}$$

where $\hat{\pi}^j_{nn'}$, $\hat{\pi}^L_{nn'}$ and $\frac{\hat{r}_{p,n}}{\hat{r}_{s,n}}$ are the trade share, labor retention share and dispersion in rental rates implied by the model. We search for values of $\hat{\hat{M}}^j_{p,n}, \hat{B}_n, \hat{\mu_n \theta_n}$ in order to minimize the sum of squared distance between the model prediction of right-hand side variables in equation (36) and the corresponding data.

Table 7: Parameters For Quantitative Model

σ^L	migration elasticity	Tombe and Zhu (2018)
$\{\sigma^j\}_{j\in J}$	elasticity of substitution	Caliendo et al. (2017)
$\{\alpha_n^j\}_{n\in N,\ j\in J}$	expenditure share	input-output table
$\{\beta^j\}_{j\in J}$	capital share	firm level data
$\{K_n\}_{n\in N}$	capital stock	Holz and Yue (2018)
$\{\bar{L}_n\}_{n\in N}$	hukou registration	2010 census data
$\{d_{nn'}^j\}_{n,n'\in N,j\in J}$	iceberg trade cost	estimated following Novy (2013)
$\{d_{nn'}^L\}_{n,n'\in N}$	migration cost	estimated following Novy (2013)
B_n	local amenities	estimated to data
$\tilde{M}_n^j$	productivity measure of firms	estimated to data
$\mu\theta_n$	private capital share	estimated to data

6.5 Identification

As we discipline our model with the right-hand side variables in equation (36), the identification of parameters are straightforward. After controlling for trade cost, if a region n and sector j's good are consistently imported more by other regions, then our model would imply higher $\tilde{M}^j_{p,n}$. Similarly, the implied level of local amenities B_n is high if a region n consistently retains more labor force after controlling for migration cost and real income in each region. Finally, equation (20) shows that $\mu_n\theta_n$ is decreasing in $r_{p,n}/r_{s,n}$, and therefore $\mu_n\theta_n$ is identified by the data variation in $r_{p,n}/r_{s,n}$.

6.6 Goodness of Fit

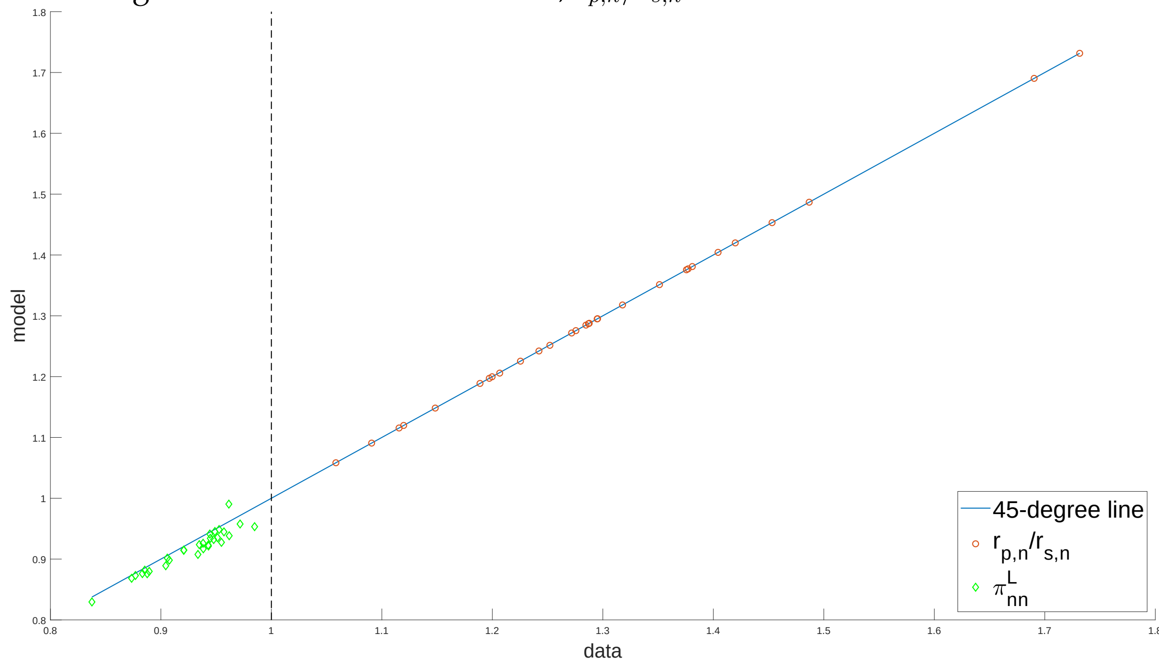
Figure 8 and 9 show our model fit to the data. Essentially our estimation approach minimize the sum of squared distance between the dots and the 45-degree line. As can be seen, our model has almost perfect fit to the dispersion in rental rates in the data. This is expected since our equation (20) established the monotonic relation between $r_{p,n}/r_{s,n}$ and $\mu_n\theta_n$ and that we let $\mu_n\theta_n$ vary at province level. Our model can also reproduce the level of provincial labor retention rates and relative sectoral outputs. In Figure 10 and 11, our model is also quite successful in capturing non-targeted outcomes, such as import and migration shares in the data. Correlations between data and model in two figures are over 0.98.

6.7 Counterfactual Exercise

So far we have developed a model of multi-regional trade and migration that features financial friction and thereby generating misallocation of capital among firms by ownership and regions. With our estimated model, we explore the second part of our research question: to what extent is financial friction causing inefficiencies and distortion in the Chinese economy? Earlier works attempted to answer similar questions (e.g. Hsieh and Klenow (2009); Midrigan and Xu (2014)), but our paper is the first to take into account regional variation in the degree of financial friction.

To answer the question, we consider two thought experiments. In the first case, financial friction improves in each region and thus the capital market between two ownership types of firms are integrated in each province. Still in this case, however, the capital market are not integrated across regions, and thus there is still misallocation of capital across the regions in the short run. We refer to this case as "SR", meaning that there is no financial friction between two ownership types of firms in the short run, but capital is

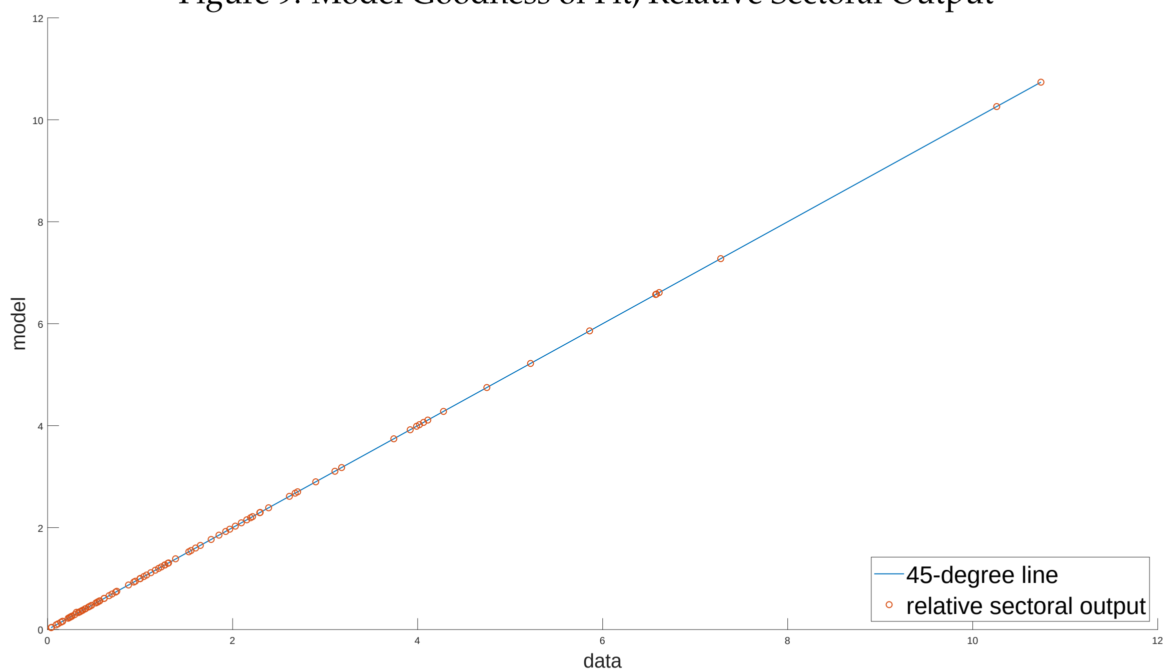
Figure 8: Model Goodness of Fit, $r_{p,n}/r_{s,n}$ and Labor Retention Share



Notes:

Model goodness of fit in terms of provincial dispersion in rental rates and labor retention share.

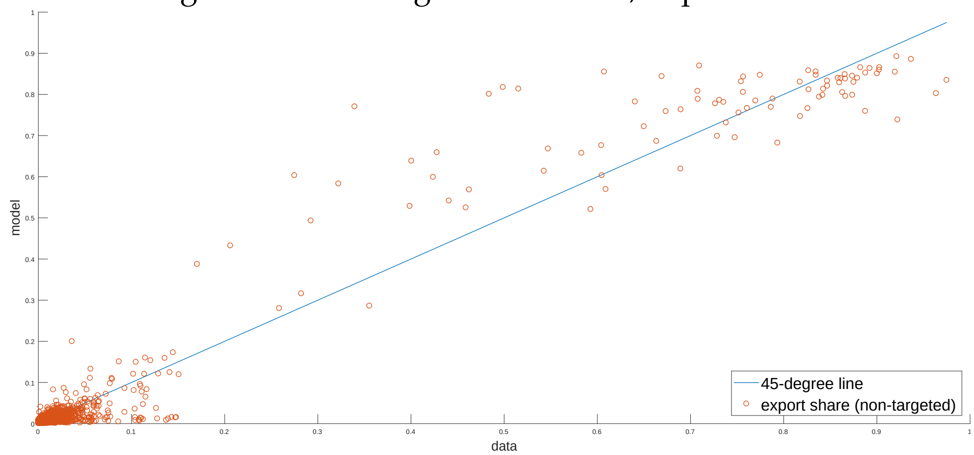
Figure 9: Model Goodness of Fit, Relative Sectoral Output



Notes:

Model goodness of fit in terms of relative sectoral output. Relative sectoral output is defined as a province's output in agriculture, manufacturing and service relative to Beijing.

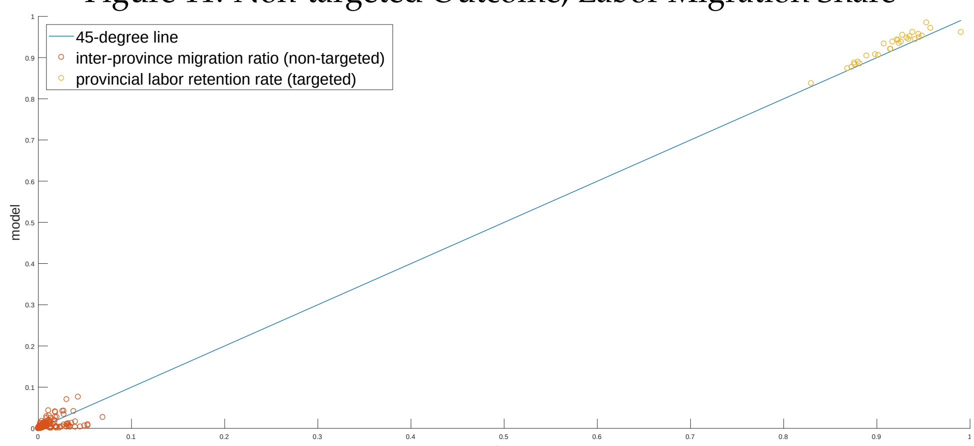
Figure 10: Non-targeted Outcome, Export Share



Notes:

This figure compares the export ratio in the data relative to the model prediction. Export ratio is a non-targeted outcome in the estimation procedure. The correlation between model and data is over 0.98.

Figure 11: Non-targeted Outcome, Labor Migration Share



Notes:

This figure compares the inter-provincial migration ratio in the data relative to the model prediction. Inter-provincial migration is a non-targeted outcome in the estimation procedure. The overall migration ratio (retention + migration ratio) has correlation over 0.99.

immobile between the provinces.

In the second case, we consider a more radical removal of financial friction and assume that entire capital market is integrated in China. This means that firms, regardless of ownership and location, face the same price of capital. We refer to this case as "LR", meaning that in the long run the movement of capital between the provinces eliminate any differences in capital prices. By comparing the equilibria of "Benchmark", "SR" and "LR", we can have an idea of how dispersion in rental rates caused by financial friction is leading to distortion in China.

Table 8 summarizes the provincial change in real income, real wage, labor supply and real income per capita. We see from the first two columns that the impact of eliminating financial friction in the short run improves the China's national real income by 1.08 percent. In the long run, elimination of financial friction between ownership types and provinces contribute 3.88 percent to the national real income. The short run impact has great heterogeneity among provinces ranging from Fujian (-0.63 percent) to Guangxi (4.73 percent). In the long run, the impact is eveny more heterogeneous. The long run removal of financial friction leads to 3.38 percent drop in Beijing's real income, whereas Qinghai rises by 24.84 percent.

From the third and fourth column, it is clear that the main increment in real income is coming from the real wage as the change in real wage closely track the change in real income across provinces in both short run and long run. Increment in labor is shown in column 5 and 6. Generally speaking, the inflow of labor is associated with the excessive increase in provincial wage beyond the national average (1.04 percent in the SR and 3.11 percent in the LR).

We then explore the key factors that explain the regional variation in gains from removal of the financial friction. We see that in Figure 13, short run gain from removal of financial friction is strongly associated with provincial dispersion in rental rates at the model Benchmark.

In Figure 13, we explore the relation between long run gain from removal of financial friction and provincial rental rate in the short run. By our definition, the private and state rental rates are equalized in the SR; hence, the SR rental rate of capital is a good provincial measure of overall scarcity of capital relative to its labor endowment. We see that in general provinces with higher short run rental rate of capital experiences higher gain from long run removal of financial friction.

Finally, we explore the extent to which decline in migration cost can attenuate the welfare loss due to financial friction. In Table 9, we show that the impact of financial friction in the short run is decreasing with respect to the decline in migration cost. However, the

Table 8: Impact of Removing Financial Friction (Percentage Change Relative to the Benchmark)

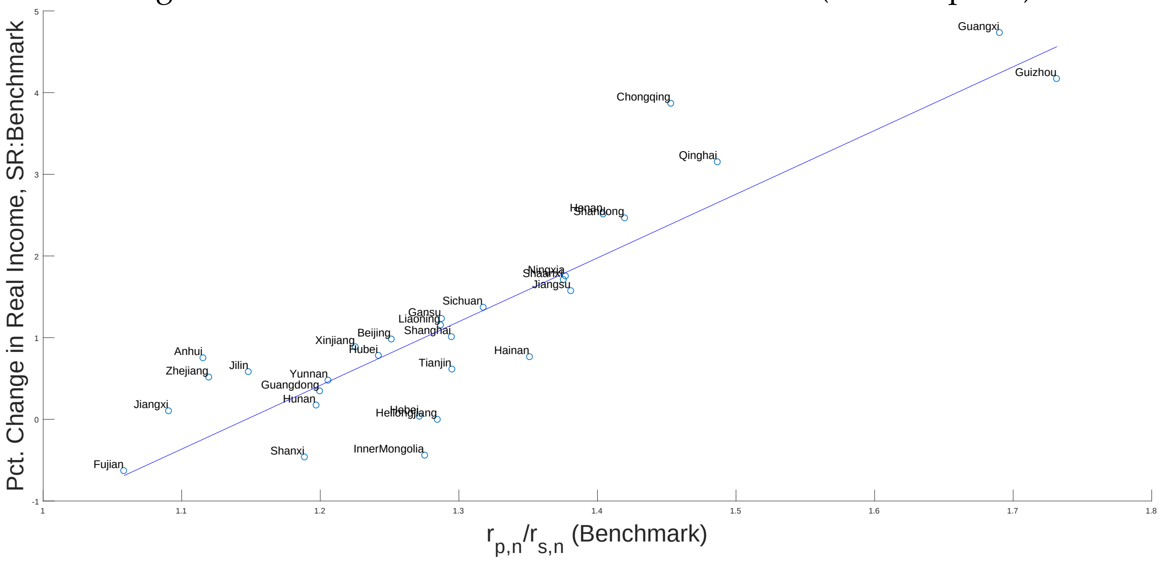
	Real Income		Real Wage		Labor		Real Income pc.	
	SR	LR	SR	LR	SR	LR	SR	LR
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
National	1.08	3.88	1.04	3.11				
Beijing	0.98	-3.38	1.12	-3.36	-0.18	-5.19	1.16	1.91
Shanghai	1.01	13.41	0.91	19.88	-0.09	10.35	1.10	2.77
Tianjin	0.61	1.91	1.12	-3.49	-0.08	-1.93	0.70	3.92
Jiangsu	1.57	-1.04	0.97	-2.86	-0.02	-2.18	1.60	1.17
Zhejiang	0.51	1.71	0.26	10.53	-0.35	1.95	0.87	-0.24
Fujian	-0.63	8.91	0.29	21.17	-0.21	3.75	-0.42	4.97
Guangdong	0.34	-0.82	0.32	0.49	-0.28	-0.79	0.63	-0.03
Shandong	2.46	8.25	2.00	21.75	0.14	3.48	2.32	4.62
InnerMongolia	-0.44	10.00	0.95	-22.32	-0.08	-6.45	-0.36	17.58
Hubei	0.78	-0.92	0.91	-6.51	-0.03	-2.05	0.81	1.15
Chongqing	3.86	1.00	2.90	-18.27	0.46	-6.52	3.39	8.05
Shaanxi	1.71	7.16	2.54	7.92	0.26	1.72	1.45	5.35
Liaoning	1.15	4.86	1.35	10.18	0.03	2.72	1.12	2.09
Jilin	0.58	1.10	1.10	-18.28	-0.03	-4.34	0.61	5.69
Ningxia	1.75	2.13	1.43	-0.53	0.01	-0.06	1.74	2.19
Hunan	0.17	18.83	0.64	40.56	-0.07	6.00	0.24	12.10
Hainan	0.76	6.39	0.75	6.38	-0.10	1.04	0.86	5.29
Henan	2.51	1.88	2.01	-15.21	0.17	-3.33	2.34	5.40
Xinjiang	0.88	3.44	0.59	-20.79	-0.21	-5.81	1.09	9.82
Sichuan	1.37	4.22	1.25	10.83	0.01	2.44	1.35	1.74
Hebei	0.03	2.55	0.98	-3.21	-0.05	-0.19	0.09	2.74
Anhui	0.75	7.81	0.46	22.77	-0.15	4.60	0.90	3.07
Qinghai	3.15	24.84	3.14	-31.01	0.45	-9.06	2.69	37.28
Jiangxi	0.10	0.11	0.37	2.18	-0.10	-0.93	0.20	1.05
Shanxi	-0.46	4.50	0.72	-1.89	-0.08	0.12	-0.38	4.38
Heilongjiang	0.00	4.57	1.04	-6.91	-0.07	-2.20	0.06	6.91
Guangxi	4.73	4.72	4.03	-9.57	0.54	-2.31	4.17	7.19
Guizhou	4.17	9.84	3.99	15.12	0.65	2.04	3.49	7.64
Yunnan	0.47	0.35	0.45	-11.40	-0.09	-2.17	0.57	2.58
Gansu	1.23	3.86	1.50	5.34	0.03	1.38	1.19	2.45

Notes:

(i) This table shows the percentage change in real income (consumption), real wage, labor supply and real income per capita under "SR" and "LR" counterfactual relative to the model Benchmark which is calibrated to the data in 2011. National average is weighted by population in each province.

(ii) Provinces are ordered in the declining order of GDP per capita in 2011.

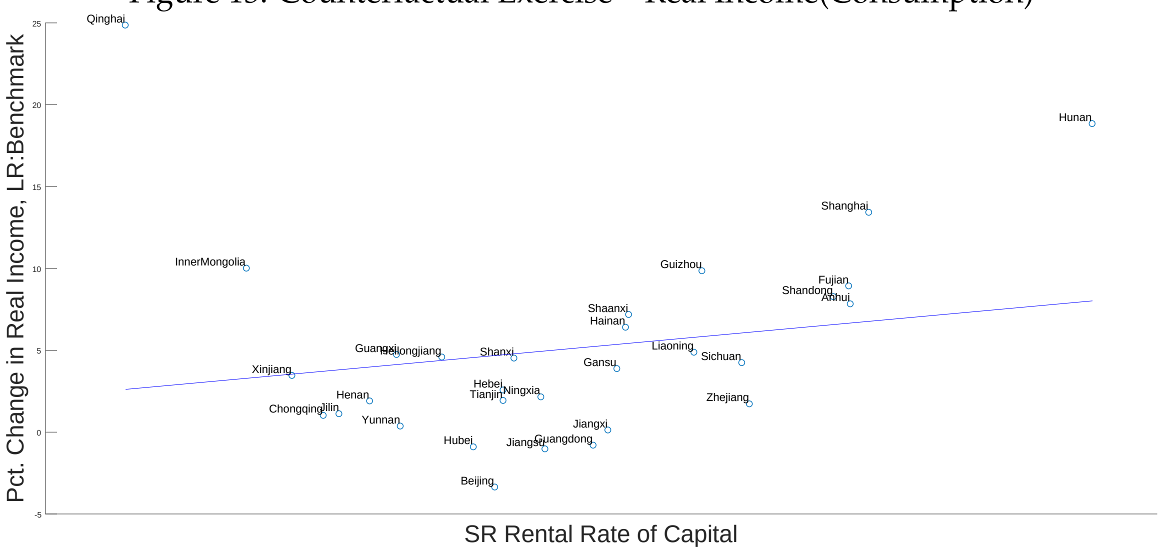
Figure 12: Counterfactual Exercise – Real Income(Consumption)



Notes:

This graph illustrates the percentage change in real income in the SR relative to the model benchmark.

Figure 13: Counterfactual Exercise – Real Income(Consumption)



Notes:

This graph illustrates the percentage change in real income relative to the model benchmark.

Table 9: Percentage Change in Real Income with Varying Migration Cost

	Migration Cost		
	Full	**Half**	**Zero**
SR:Benchmark	1.08	1.05	1.00
LR:Benchmark	3.88	4.51	6.01

Notes:

This table shows the percentage change in real income under various assumptions about migration cost. First column corresponds to the first line of column one and two in Table 8.

long run impact of financial friction is increasing with respect to decline in migration cost. The reason is that in the long run, reallocation of capital calls for even greater reallocation of labor. This effect is even stronger when the migration cost is low. That is why removal of financial friction in the long run has greater impact on welfare when the migration cost is low.

7 Conclusion

We construct an economic geography model that embeds the financial friction in the style of Antràs and Caballero (2009) to explain the capital and labor movements in China. Financial friction is reflected in private firms excess cost of using capital relative to state firms. Overall, this raises the average MRPK where frictions are high, thus making it more attractive for lenders to direct their loans to provinces where financial markets do not function well.

To test the model hypothesis, we show that a sufficient statistic for a province's level of financial friction is the difference in difference of private and state firms' rental rates of capital and their market shares. The reduced-form OLS regressions at the province level support this hypothesis. Using data from 2002 to 2012, we show that financial friction explains inflows of capital, outflows of labor and declining wages after accounting for regional and time fixed effects.

To quantitatively gauge the economic disruption caused by the financial friction, we estimate our quantitative model to reproduce the salient features of the data in year 2011. We show that the short run benefit of eliminating financial friction in China amounts to 1.08 percent of real income and in the long run the benefit rises to 3.88 percent of real income nationally. The gain from elimination of financial friction is strongly correlated with the degree of financial friction in the first place – confirming the sharp prediction of welfare loss associated with misallocation studied in Hsieh and Klenow (2009).

Interestingly, we show that decline in migration cost reduces the negative impact from financial friction in the short run; however, it amplifies the negative impact in the long run. The reason is the complementarity between movement of capital and labor. In other words, capital mobility across provinces benefit more to the economy when labor faces low moving cost.

Our paper demonstrates the importance of streamlining capital access to private firms to unleash greater growth potential in China. However, our model abstract from the problem of capital accumulation and thus understates the disruption by financial friction. Future work remains to evaluate both static and dynamic loss from financial friction in China.

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Appendices

A Measure of Financial Friction

Our approach to measure firm-level financial friction closely follows Wu (2018), but there are a few key differences. In Wu, firm's static profit is defined as the difference in revenue minus labor cost as discussed in section 2.1 of Wu's paper. This means that the optimized profit relative to revenue can be expressed as (equation (2) in Wu)

$$\frac{\pi_i}{R_i} = \frac{1}{\sigma_i} + \beta_i(1 - \frac{1}{\sigma_i}) \tag{A.1}$$

This expression is very convenient for Wu for two reasons. First, the profit-revenue is directly observed from the data. Second, Wu's key equation (after Taylor approximation) can be expressed as

$$\ln(ARPK_i) = -\ln\left[\frac{1}{\sigma_i} + \beta_i(1 - \frac{1}{\sigma_i})\right] + \frac{1}{\sigma_i\left[\frac{1}{\sigma_i} + \beta_i(1 - \frac{1}{\sigma_i})\right]} + \ln(MRPK_i),$$

which naturally leads to the estimating equation (6) of Wu (2018).

In contrast, our theory model assumes that monopolistic firms are optimizing over labor and capital simultaneously, and the profit is the residual of revenue after labor cost and capital cost have been net out. Since the pricing rule follows simple markup $\frac{\sigma_i}{\sigma_i - 1}$ over marginal cost, the profit can be simply expressed as $\pi = R_i/\sigma_i$. This expression is inconsistent with equation (A.1) and therefore direct application if Wu's approach is not feasible.

Instead, we apply Taylor approximation of equation (23) around $1 - 1/\sigma_i$ to obtain

$$\ln(MRPK_i) = \ln(ARPK_i) + \ln(1 - \frac{1}{\sigma_i}) + (\beta_i - 1) \tag{A.2}$$

The difference in technology (the term $\beta_i - 1$) is controlled by 4-digit industry fixed effects (482 dummies) in equation (24). We calculate the median of the estimated $\ln(M\hat{R}PK_i)$ by ownership and we use the difference between the private firms' median $\ln(M\hat{R}PK_i)$ and state firms' median $\ln(M\hat{R}PK_i)$ as our measure of provincial financial friction. The private firm's firm-specific level of financial friction is measured by the difference in firm level $\ln(M\hat{R}PK_i)$ and the median of state firms' $\ln(M\hat{R}PK_i)$ in the same province.

B Proof of Proposition 1

Under the assumption that each province in China is "small" relative to the rest of the world, the three defining equations that determine $\{w_n, r_{p,n}, r_{s,n}\}$ can be written as:

$$\mu\theta_n K_n r_{p,n} = \left(w_n^{1-\beta} r_{p,n}^{\beta}\right)^{1-\sigma} \tilde{\Phi}_{n,p}\beta(\sigma-1)/\sigma \tag{A.3}$$

$$(1-\mu\theta_n) K_n r_{s,n} = \left(w_n^{1-\beta} r_{s,n}^{\beta}\right)^{1-\sigma} \tilde{\Phi}_{n,s}\beta(\sigma-1)/\sigma \tag{A.4}$$

$$L_n w_n = \left[\left(w_n^{1-\beta} r_{p,n}^{\beta}\right)^{1-\sigma} \tilde{\Phi}_{n,p} + \left(w_n^{1-\beta} r_{s,n}^{\beta}\right)^{1-\sigma} \tilde{\Phi}_{n,s}\right](1-\beta)(\sigma-1)/\sigma \tag{A.5}$$

where $\tilde{\phi}_{n,i} \equiv \sum_{n'} E_{n'} P_{n'}^{\sigma-1} \left(d_{nn'}/z_{i,n}\right)^{1-\sigma}$. We log-linearize the three equations and introduce the notation $\hat{x}$ to denote $d\ln(x)$. Express the three equations in terms of changes in key endogenous variables $\{w_n, r_{p,n}, r_{s,n}\}$ and the parameter of interest θ_n:

$$\hat{\theta}_n + \hat{r}_{p,n} = (1-\sigma)(1-\beta)\hat{w}_n + (1-\sigma)\beta\hat{r}_{p,n}$$

$$-\tilde{\theta}_n\hat{\theta}_n + \hat{r}_{s,n} = (1-\sigma)(1-\beta)\hat{w}_n + (1-\sigma)\beta\hat{r}_{s,n}$$

$$(1+\sigma^L)\hat{w}_n = \lambda\left[(1-\sigma)(1-\beta)\hat{w}_n + (1-\sigma)\beta\hat{r_{p,n}}\right] + (1-\lambda)\left[(1-\sigma)(1-\beta)\hat{w}_n + (1-\sigma)\beta\hat{r_{s,n}}\right]$$

where we define $\tilde{\theta}_n \equiv \frac{\mu\theta_n}{1-\mu\theta_n}$ and $\lambda \equiv \frac{\left(w_n^{1-\beta} r_{p,n}^{\beta}\right)^{1-\sigma}\tilde{\Phi}_{p,n}(1-\beta)(\sigma-1)/\sigma}{L_n w_n}$

Using the log-linearized system of equations, we can express $\{\hat{w}_n, \hat{r}_{p,n}, \hat{r}_{s,n}\}$ in terms of change in the parameter of interest $\hat{\theta}_n$.

$$\begin{aligned}
\hat{w}_n &= \left[\beta(1-\sigma)-1\right]\beta(1-\sigma)\left[(1-\lambda)\tfrac{\mu\theta_n}{1-\mu\theta_n} - \lambda\right]\tfrac{\hat{\theta_n}}{\Delta} \\
\hat{r}_{p,n} &= \left\{(1-\sigma)^2\beta(1-\beta)\tfrac{\lambda-\mu\theta_n}{1-\mu\theta_n} + \sigma - \left[\beta(1-\sigma)-1\right]\sigma^L\right\}\tfrac{\hat{\theta}_n}{\Delta} \\
\hat{r}_{s,n} &= \left\{(1-\sigma)^2\beta(1-\beta)\tfrac{\lambda-\mu\theta_n}{1-\mu\theta_n} - \left[\sigma - \sigma^L\left[\beta(1-\sigma)-1\right]\right]\tfrac{\mu\theta_n}{1-\mu\theta_n}\right\}\tfrac{\hat{\theta}_n}{\Delta}
\end{aligned}$$

where $\Delta = \left[1-\beta(1-\sigma)\right]\cdot\left[\sigma^L\left[\beta(1-\sigma)-1\right]-\sigma\right] > 0$

Taking the ratio of equation (A.3) and (A.4) yields:

$$\frac{\lambda}{1-\lambda}\frac{1-\mu\theta_n}{\mu\theta_n} = \frac{r_{p,n}}{r_{s,n}}$$

Note that our assumption Assumption 1 immediately implies that $\lambda > \mu\theta_n$. Therefore, we have $\hat{w}_n/\hat{\theta}_n > 0$, i.e. equilibrium wage increases with θ_n. Similarly we can prove $\hat{r}_{p,n}/\hat{\theta}_n < 0$. For $r_{s,n}$, however, we need stronger assumption on lower θ_n that $\frac{\hat{r}_{s,n}}{\hat{\theta}_n}$ is negative if $\theta_n < \left[\frac{\beta(1-\beta)(1-\sigma)^2}{\sigma-\sigma^L[\beta(1-\sigma)-1]+\beta(1-\beta)(1-\sigma)^2} - \frac{r_{s,n}}{r_{p,n}}\right] / \left[\mu\left(1-\frac{r_{s,n}}{r_{p,n}}\right)\right]$ is satisfied.

Note that the preceding inequality suggests:

$$\theta_n \mu \left(1 - \frac{r_{s,n}}{r_{p,n}}\right) < \left(\frac{\beta(1-\beta)(1-\sigma)^2}{\sigma - \sigma^L\left[\beta(1-\sigma)-1\right] + \beta(1-\beta)(1-\sigma)^2} - \frac{r_{s,n}}{r_{p,n}}\right)$$

Define $\mu^* \equiv \frac{\beta(1-\beta)(1-\sigma)^2}{\sigma-\sigma^L[\beta(1-\sigma)-1]+\beta(1-\beta)(1-\sigma)^2}$. Apparently the inequality satisfies for any $0 < \mu < \mu^*$ for θ_n that is close to 1. Thus we provide a sufficient condition for $\hat{r}_{s,n}/\hat{\theta}_n$ to be negative for regions of θ_n close to 1. □

C Multisector Extension

We extend our benchmark model to account for sectoral heterogeneity in the data. Let j denote a specific sector that belongs to the set of sectors J. Our benchmark model can be simply extended to a multisector one by nesting sectoral consumption under upper Cobb-Douglas utility function as follows:

$$C_n = \prod_j \left(\frac{C_n^j}{\alpha_n^j}\right)^{\alpha_n^j}$$

where C_n^j denotes the sectoral consumption in sector s and α_n^j denote the expenditure share in sector j in region n. Sectoral consumption is CES aggregate of varieties of goods in sector j:

$$C_n^j = \left[\sum_i \int_{\omega \in \Omega_{i,n}^j} C_{i,n}^j(\omega)^{\frac{\sigma^j-1}{\sigma^j}}\, d\omega\right]^{\frac{\sigma^j}{\sigma^j-1}} \tag{A.6}$$

Similarly define the sectoral price index as:

$$P_n^j = \left[\sum_i \int_{\omega \in \Omega_{i,n}^s} p_{i,n}^s(\omega)^{1-\sigma^j}\, d\omega\right]^{\frac{1}{1-\sigma^j}} \tag{A.7}$$

Then the regional price index can be expressed as the Cobb-Douglas product of sectoral prices:

$$P_n = \prod_j \left(P_n^j\right)^{\alpha_n^j} \tag{A.8}$$

A key equation governing the goods market in the model is equation (5) that characterizes the flow of goods across the regions. Analogous to equation (5), the market share in the multisector extension is:

$$\pi^j_{i,nn'} = \frac{M^j_{i,n}\left(w_n^{1-\beta^j} r_{i,n}^{\beta^j} d^j_{nn'}/z^j_{i,n}\right)^{1-\sigma^j}}{\sum_n \sum_i M^j_{i,n}\left(w_n^{1-\beta^j} r_{i,n}^{\beta^j} d^j_{nn'}/z^j_{i,n}\right)^{1-\sigma^j}} \tag{A.9}$$

The multisector extension does not alter the labor side of the model. Thus, we only spell out the equations that characterize the goods and factor market in our model. Analogous equations to (7), (8), (10), (11) and (14) are:

$$\mu_n\theta_n K_n r_{p,n} = \sum_j \sum_{n'} E_{n'}\alpha^j_{n'}\pi^j_{p,nn'}\beta^j(\sigma^j-1)/\sigma^j, \ \ \forall n \tag{A.10}$$

$$(1-\mu_n\theta_n)K_n r_{s,n} = \sum_j \sum_{n'} E_{n'}\alpha^j_{n'}\pi^j_{s,nn'}\beta^j(\sigma^j-1)/\sigma^j \ \ \forall n \tag{A.11}$$

$$L_{p,n}w_n = \sum_j \sum_{n'} E_{n'}\alpha^j_{n'}\pi^j_{p,nn'}(1-\beta^j)(\sigma^j-1)/\sigma^j \ \ \forall n \tag{A.12}$$

$$L_{s,n}w_n = \sum_j \sum_{n'} E_{n'}\alpha^j_{n'}\pi^j_{s,nn'}(1-\beta^j)(\sigma^j-1)/\sigma^j \ \ \forall n \tag{A.13}$$

and

$$E_n = w_n L_n + r_{p,n}\mu_n\theta_n K_n + r_{s,n}(1-\mu_n\theta_n)K_n + \sum_j \sum_i \sum_{n'} E_{n'}\alpha^j_{n'}\pi^j_{i,nn'}/\sigma^j \tag{A.14}$$

D Dynamic Extension

Developing our model's dynamics allows us to link regional difference in $r_{s,n}$ to interprovincial capital flows. When we assume that private capital is scarce enough that the credit constraint is always binding, only the portion of capital allocated to the state sector, $(1-\mu\theta_n)K_n$ is available to move across the regions.

Starting from a steady state equilibrium where regional capital flows do not occur, AC shows that costless trade in goods is not sufficient to achieve factor price equalization across the regions when financial friction persists. This is especially true in our model because neither trade in goods nor migration are costless.

As discussed in the static component, regional differences in financial contractability θ_n is a key factor that determines the difference in $r_{s,n}$, the rental rate of capital whose flow is not limited. This is also true in the steady state. On the path to the new steady state, however, regions with high financial contractability, θ_n and resulting low $r_{s,n}$ can send capital to other regions to earn higher rate of return. These regions experience net capital outflow and thus have positive net export. Regions with low financial contractability θ_n and high $r_{s,n}$, however, become net importers.

Formally, we assume that time evolves continuously and use the conventional terminology $\dot{x} \equiv dx(t)/dt$ to denote the marginal change in variable x with respect to time. Workers spend all income on consumption and do not accumulate any capital. Workers' migration decision is also myopic. State and private owners spend ϕ share of their income on consumption. We assume that production of capital good is the same as the utility function for capital owners. Let $R_{i,n,t}$ denote the real return to holding a unit of capital type i. Then $R_{i,n,t}$ can be expressed as:

$$R_{i,n,t} = \frac{r_{i,n,t}}{P_{n,t}} + \frac{\dot{P}_{n,t}}{P_{n,t}} \tag{A.15}$$

where the first term denotes the dividend-price ratio and the second term denotes the change in the price of capital. Defining $W_{i,n,t} \equiv K_{i,n,t}P_{n,t}$ as the wealth of capital owner type i, the accumulation of private and state owners' wealth respectively follow the paths below:

$$\dot{W}_{i,n,t} = -\phi W_{i,n,t} + w_{n,t}M_{i,n} + R_{i,n,t}W_{i,n,t} \tag{A.16}$$

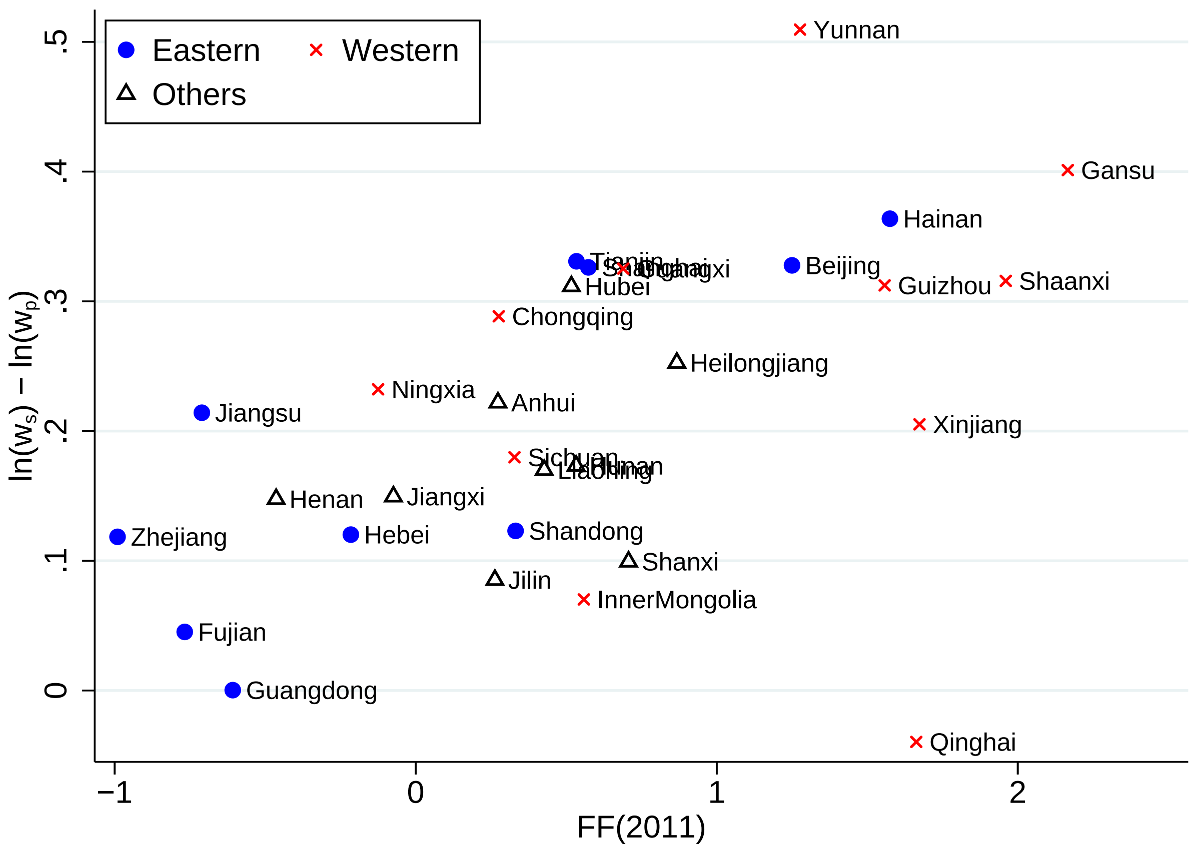
where $M_{i,n}$ is the measure of capital owner type i in region n. Summing equation (A.16) over $i = \{p, s\}$ yields the relation:

$$\phi \left(W_{p,n,t} + W_{s,n,t}\right) + \dot{K}_{n,t}P_{n,t} = r_{p,n,t}K_{p,n,t} + r_{s,n,t}K_{s,n,t} \tag{A.17}$$

in which the left side is total consumption and investment and the right is the total income of capital owners. When $\phi = 1$ (no savings), our static equilibrium describes the instantaneous equilibrium for any given level of $\{K_{p,n,t}, K_{s,n,t}\}$. When a region with lower $r_{s,n,t}$ (high θ_n) opens its capital account with region n' that has higher $r_{s,n',t}$, it immediately experiences net capital outflow to region n'.

E Additional Tables and Figures

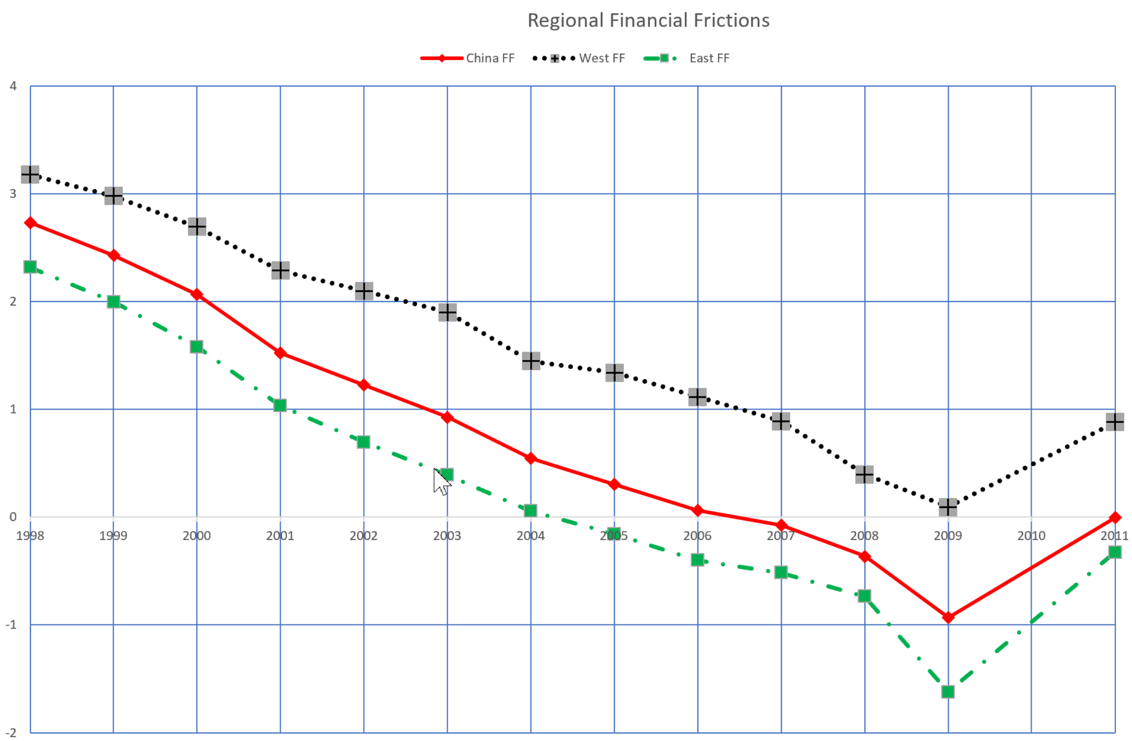
Figure A.1: State-private Wage Gap and Provincial Financial Friction (Year 2011)



Notes:

(i) Source: Chinese MLE data and authors' calculation based on equation (26).

Figure A.2: China Financial Friction: Ln MRPK DPEs - Ln MRPK SOEs

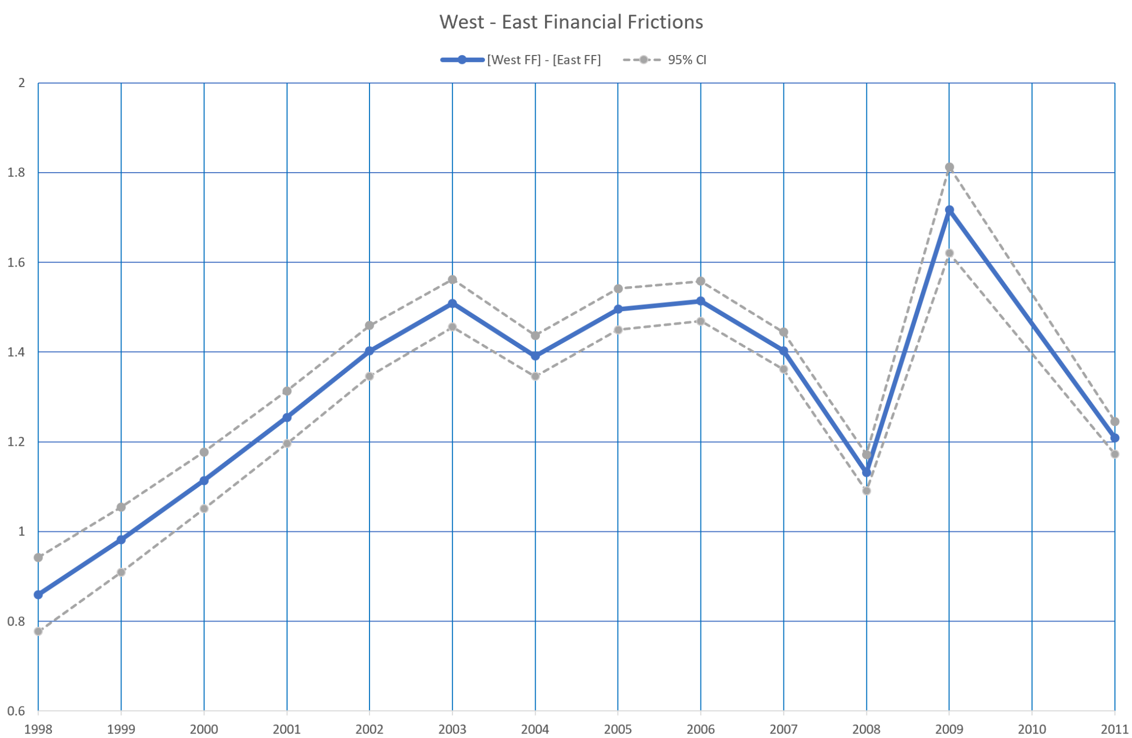


Notes: SOE = State Owned Enterprises; DPE = Domestic Private Enterprises

(i) Data are taken from the Survey of Large and Medium Enterprises which includes all industrial firms with sales over 5 million yuan.

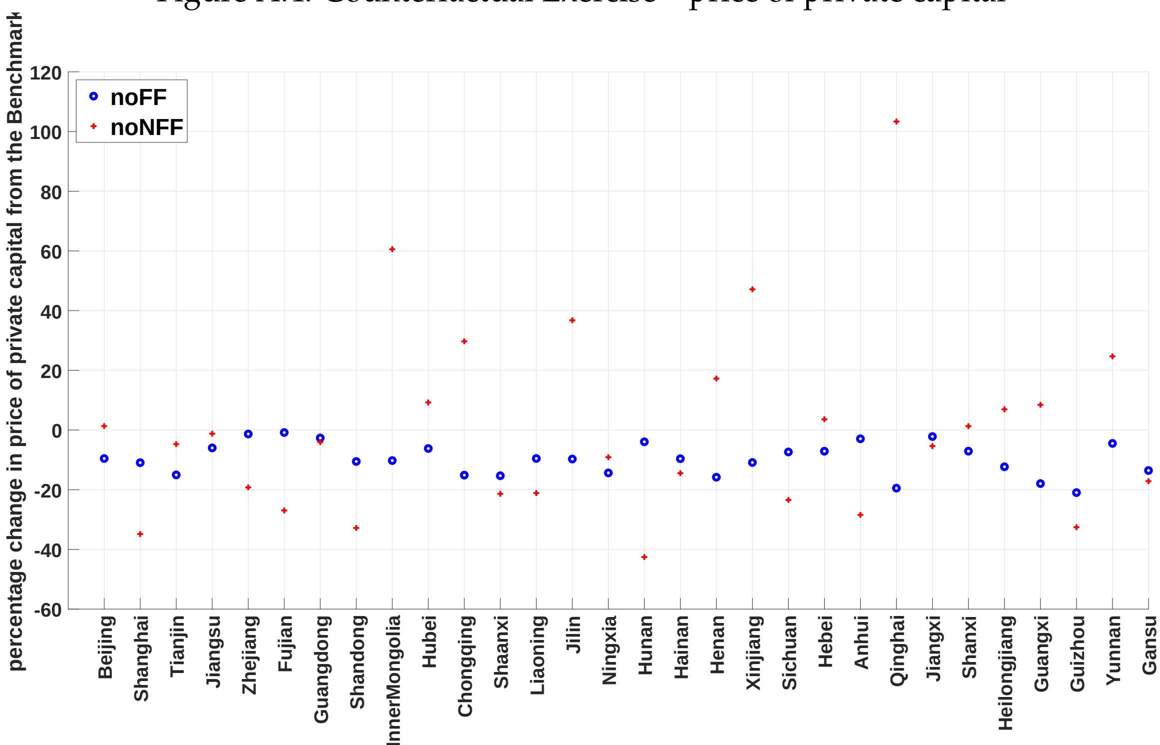
(ii) We follow Brandt et al. (2017) in determining ownership.

Figure A.3: West (Ln MRPK DPEs-Ln MRPK SOEs) - East (Ln MRPK DPEs-Ln MRPK SOEs)



Notes: See notes to Figure A.2.

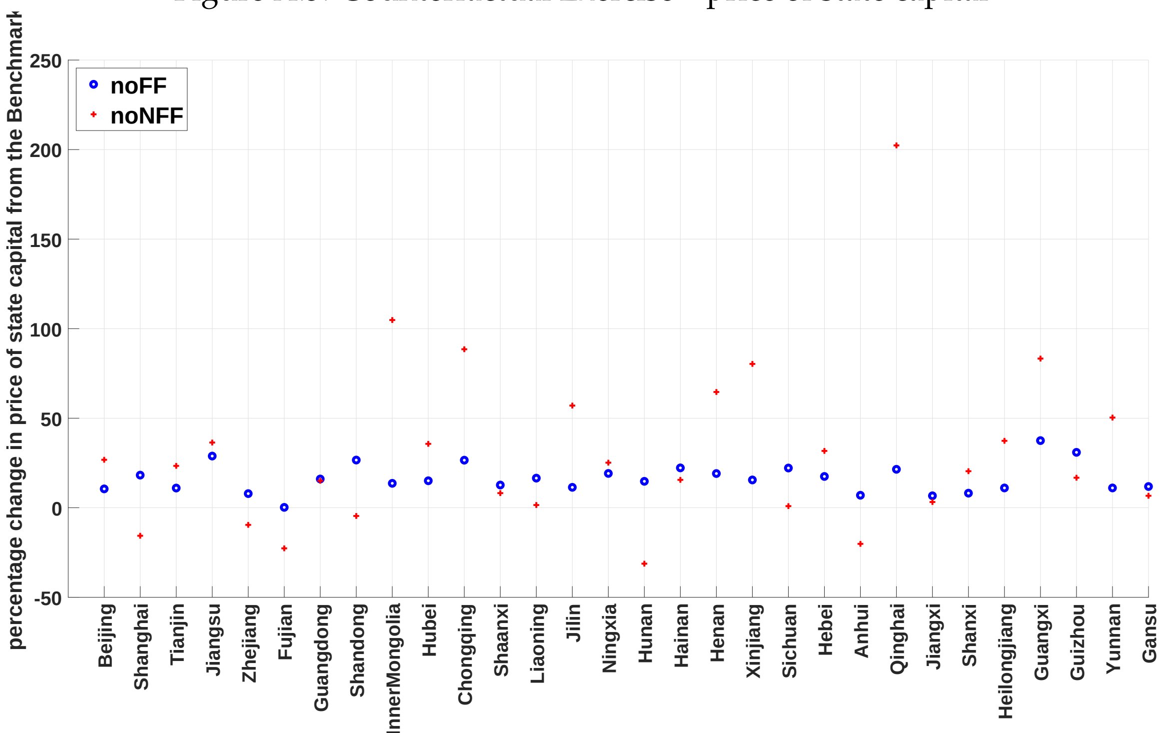
Figure A.4: Counterfactual Exercise – price of private capital



Notes:

This graph illustrates the percentage change in prices of private capital in counterfactuals relative to the model benchmark.

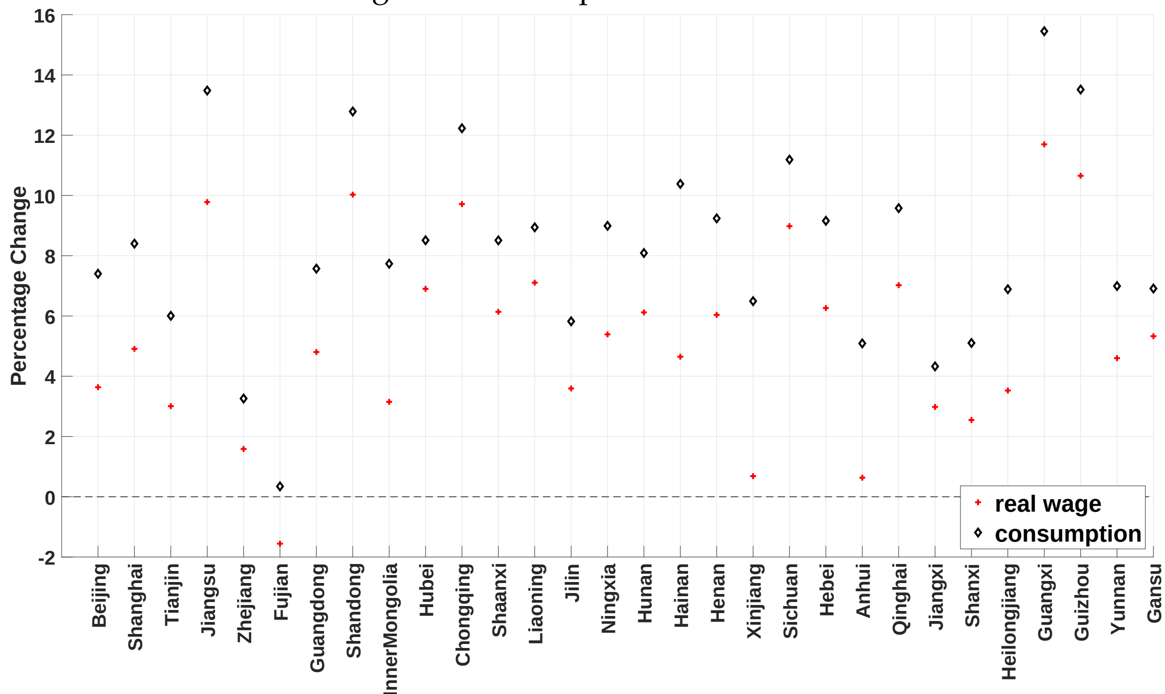
Figure A.5: Counterfactual Exercise – price of state capital



Notes:

This graph illustrates the percentage change in prices of state capital in counterfactuals relative to the model benchmark.

Figure A.6: Comparative Statistics

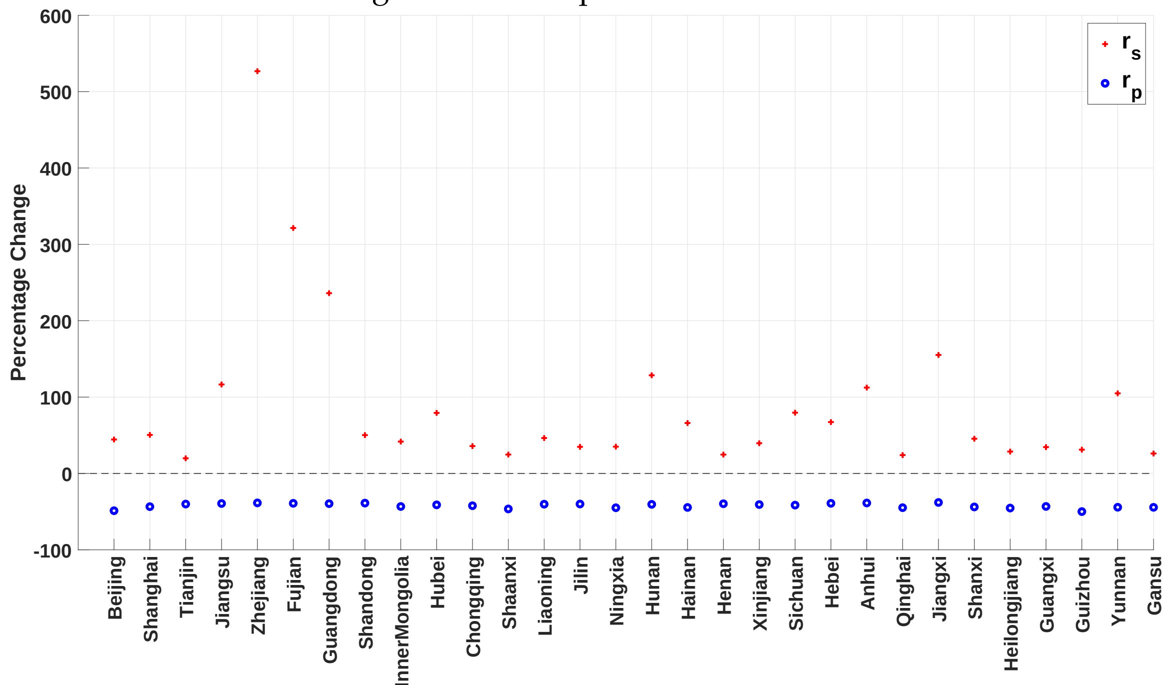


Notes:

(i) This graph illustrates the percentage change in provincial wage, total income and real consumption when θ_n in the corresponding province improves by 1 percent. For example, starting from the Benchmark equilibrium, when Beijing's θ_n improves by 1 percent, the graph shows that Beijing's real consumption increases by 1.69 percent.

(ii) Except for Beijing and Shanghai, provinces are in the descending order of provincial GDP.

Figure A.7: Comparative Statistics

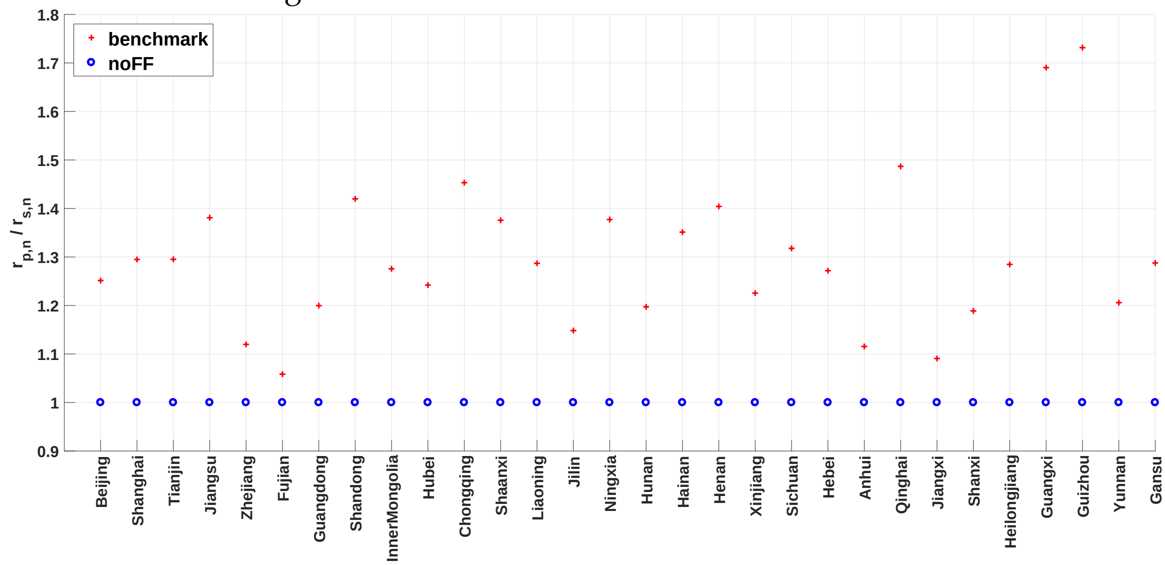


Notes:

(i) This graph illustrates the percentage change in provincial price of capital when θ_n in the corresponding province improves by 1 percent. For example, starting from the Benchmark equilibrium, when Beijing's θ_n improves by 1 percent, the graph shows that Beijing's price of state capital increases by 53%.

(ii) Except for Beijing and Shanghai, provinces are in the descending order of provincial GDP.

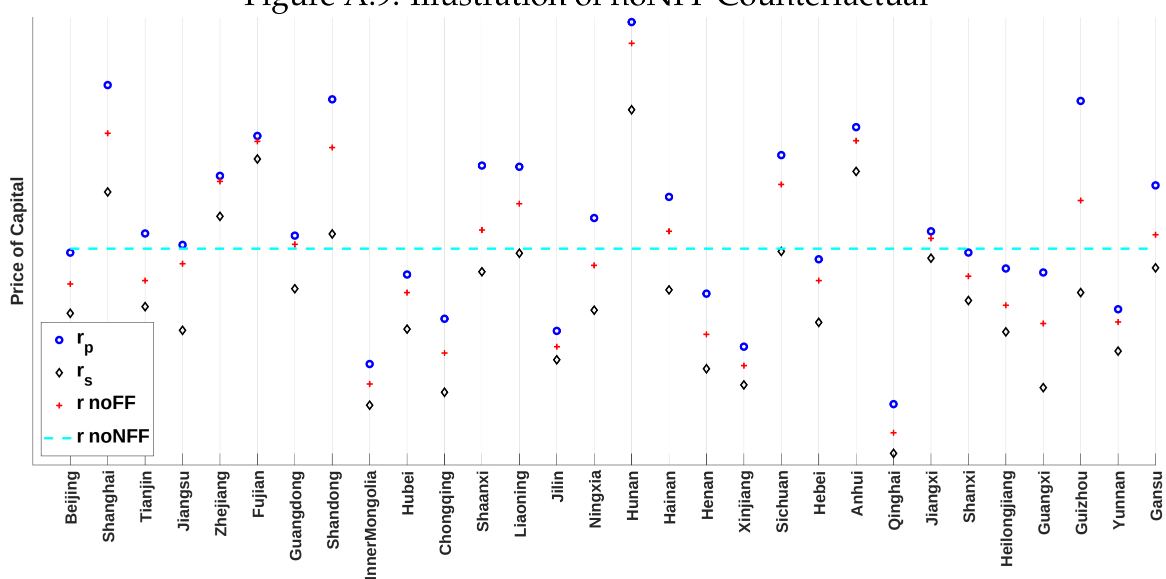
Figure A.8: Illustration of noFF Counterfactual



Notes:

In the noFF counterfactual, we integrate the financial market for private and state firms in each province. In the noFF counterfactual, $r_{p,n}/r_{s,n}$ are reduced to 1.

Figure A.9: Illustration of noNFF Counterfactual



Notes:

(i) In the noNFF counterfactual, we integrate the financial market for all firms in China. In the noNFF counterfactual, all firms face the same price of capital regardless of ownership or region.