Regional Convergence or Just An Illusion? Place-based Land Policy and Spatial Misallocation *

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Abstract

We study how place-based land allocation policy can create spatial misallocation. Such policy may seem to "help the region", but actually hurt workers in the region. Combining micro-data and a spatial equilibrium model, we investigate a major policy change of distributing more land to under-developed non-eastern inland regions in China. First, using a method combining RD and DID, we show causal evidence that this inland-favoring policy increased land prices and decreased firm-level TFP in developed eastern regions relative to non-eastern regions. Second, we build a spatial equilibrium model featuring worker mobility and both residential and production floor space constraints. In the model, the inland-favoring policy tightens urban land supply in developed eastern cities, and consequently, prevents workers from migrating there. Counterfactuals reveal that the national TFP and urban output would have been 7.3% and 2.4% higher in 2010 if the policy had not been implemented. Moreover, national-level income inequality would have been reduced by more than 30% and wages of workers from poor regions would have been increased by 1-2%. The result shows that the inland-favoring policy seems to reduce the regional gap. However, it in fact, causes TFP and output losses, worsens inequality, and unfavorably hurts workers from under-developed regions by hindering their migration to higher-paid developed cities.

Keywords: Place-based Policy; Land Policy; Spatial Misallocation; Regional Inequality; China;

JEL Classification Numbers: R58, E24, J61, R52;

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1 Introduction

Most countries regulate land allocation using place-based policies. Many of these regulations, such as land supply quotas, enterprise zones, and local infrastructure investment plans, are implemented to boost the economy in specific areas (Neumark and Simpson, 2015). They commonly target on underperforming areas, such as deteriorating downtown business districts and disadvantaged regions, to ensure balanced development. However, such balanced development may be achieved at the cost of generating spatial misallocation. Moreover, the balance across regions does not necessarily mean equality among people, when the place-beased policy may deter people from migrating to places with higher productivity. Some place-based policies may result in a paradox of helping the region but hurting people from the region. These issues are often missing in place-based policy discussions.

In this paper, we study the impact of place-based land allocation policy on economic development using China's structural change of the national land allocation policy in 2003, also known as the inland-favoring policy. Similar to other place-based policies, this policy change aims to mitigate the unbalanced development across regions due to the rapid economic growth in the eastern regions near the coastline (Lin, 2011; Fleisher, Li, and Zhao, 2010).[1] To alleviate the substantial regional inequality in economic development and help the non-eastern region to catch up, the Chinese central government decided to structurally change its land allocation policy in 2003.[2] The new policy reversed the demand-driven land distributing pattern, which favored fast-growing eastern cities before 2003, to the development-encouraging distributing pattern, which favored under-developed non-eastern cities after 2003.

How severely does this place-based land allocation policy generate the potential spatial misallocation? What is the cost we have to pay to balance the regional development? Furthermore, does the policy achieve its initial goal to balance regional development?

We analyze the consequences of this policy change in three steps. First, we use a method combining Regression Discontinuity with Difference-in-Difference (RD-DID) and show that this policy change increased relative land prices and decreased relative firm-level TFP in eastern areas. Second, we develop a spatial equilibrium model to quantify the aggregate impact of the policy

[1] China is currently the largest developing economy and experienced remarkable economic growth after the 1970s. However, the development in China is very unbalanced across regions. Most of the coastline lies in the eastern region, which gives them the keys to the global market. Consequently, eastern areas achieved massive growth, and the gap between eastern cities and non-eastern cities was enlarged over and over, which became a big concern of the Chinese government.

[2] Different from western countries, the state owns urban land in China. The central government plays a dominant role in land usage regulation and sets a strict cap on how much land can be used for construction in each city each year. Thus, construction land allocation is a powerful policy tool for the Chinese government.

using Census data from 2005 and 2010. We find that more developed eastern cities have higher fundamental productivity and face more severe land supply constraints. Finally, by conducting a counterfactual exercise of eliminating this inland-favoring land supply policy, we find that total output and measured TFP would have been 7.3% and 2.4% higher in 2010. Although the output gap across geographic regions would have been increased, the national-level inequality actually can be reduced. These results show that the placed-based land allocation policy does create spatial misallocation, which not only lowers productivity and output, but also worsens inequality.

In the first part of this study, we empirically investigate the effect of the inland-favoring land supply policy in 2003 on land prices and firm-level TFP in different regions. The land price data is collected from the China Land Market Website (http://www.landchina.com/) at the land parcel level. The firm-level TFP is calculated using data from the National Industrial Enterprise Database. A typical identification problem is that land parcels and firms in the eastern region are usually very different from those in the non-eastern region regarding both observed and unobserved characteristics. To solve this endogeneity issue, we employ a method combining Border Regression Discontinuity Design (Black, 1999) and Difference-in-Difference (RD-DID). The basic idea is that land parcels and firms within a minimal bandwidth just on the border are very similar, no matter whether they are located on the eastern side or the non-eastern side. Thus, their prices or TFP should have a similar changing trend. Then we can implement DID strategy on these samples to identify the effect of the inland-favoring land supply policy. The variations we use are prices/TFP differences between eastern and non-eastern land parcels/firms that are very close to the border, before and after 2003. Using traditional event study regressions, we find that the time trend of land prices and firm-level TFP are parallel before the policy, which validates our RD-DID specification.

In the main regression, we find that the inland-favoring land supply policy in 2003 led to 3.3-9.4% increase in the land prices in the eastern developed region, compared with the non-eastern region. Furthermore, this policy also reduced the firm-level TFP in the eastern region by 0.34-0.55%, compared with the non-eastern region. Thus, the empirical analysis shows that the inland-favoring land supply policy shrank the productivity gap between the eastern and the non-eastern regions. However, it comes with the cost of slower growth in the eastern region and possibly the overall economy in China. In addition, the land and housing prices in eastern areas rocketed up, which led to severe concern in the society (Fang and Huang, 2020).

In the second step of this study, we construct a spatial general equilibrium model (Eaton and Kortum, 2002; Ahlfeldt et al., 2015) to quantify the aggregate effects of China's land supply scheme. There are K cities in this model and each city has two sectors, urban and rural. Each worker is endowed with a skill level, either high or low, and a specific Hukou (home) city and Hukou sector. Their utility is determined by the location taste shock, goods consumption, amenities, and floor space consumption. They need to choose their working locations (city-sector pair) according to wages, housing prices, and migration costs. We assume that their location taste shock follows a Fréchet distribution, which gives us a closed-form migration flow equation across city-sector pairs. In urban areas, final goods production employs a Cobb-Douglas technology with factor augmenting productivities, using production floor space and a CES aggregator of high/low skill labors as inputs. Land supply in the urban areas in each city is exogenously given based on government's policy, and construction firms can convert land to floor space proportionally (with different ratios in different cities). There is also a tax-equivalent land use regulation to restrict the relative price of production floor space to residential floor space, which helps to clean the floor space market. In rural areas, the production function has a simple Cobb-Douglas form with total labor as the input. The residential cost in the rural area is also simplified, which equals a discounted fraction of the cost in the urban area of the same city. Using data from the Population Census, the City Statistic Yearbooks, and the Urban Statistic Yearbook in 2005 and 2010, we calibrate and quantify the model. We find that in developed eastern cities, the total land supply is not enough, and the per capita land supply is much smaller than that in under-developed cities.

Finally, using this model, we implement a counterfactual analysis to examine what will happen if the pre-2003 land supply policy is maintained. We assume that in the counterfactual world, each city's land supply growth rate is the same before and after 2003. That is, the central government does not implement the affirmative action style inland-favoring policy. We find that, by removing this inland-favoring policy, we can increase the land supply in eastern cities with higher productivity and decrease the floor space prices. It then attracts more people to migrate to these cities and results in a 2.2% (2.4%) increase in the total national output in 2005 (2010). We also find that the productivity loss due to the inland-favoring policy is enormous. If we remove the policy, the national-level TFP will increase by 6.2% in 2005 and by 7.3% in 2010. Meanwhile, the removal of the policy can reduce the output and productivity in under-developed cities and cause a larger regional output gap. It seems that the inland-favoring policy helps the poor workers by balancing regional development. However, this is in fact, not the case. We find that removing the inland-favoring policy can lead to about 30% decrease in the national-level inequality measured by Theil Index and about 1-2% increase in the average wage income of workers from under-developed areas. The reason is that this policy reduces labor demand and increase housing cost in developed cities, which prevents workers from under-developed cities to migrate to developed cities with higher wages.

In general, the inland-favoring land supply policy resulted in severe land misallocation. It not only caused overall output and TFP losses, but also exacerbated the inequality issue, and hurt workers in under-developed regions whom it intended to help. These analyses teach us an important lesson that even if place-based policies sometimes can help specific regions, they may actually harm people from those places.

Literature Review Our study extends the current literature in several dimensions. First, it draws on evidence for the effects of place-based policy. Many studies have investigated different kinds of place-based policies in developed countries from different perspectives (Neumark and Simpson, 2015), including enterprise zones (Neumark and Kolko, 2010; Freedman, 2013; Ham et al., 2011; Busso, Gregory, and Kline, 2013; Reynolds and Rohlin, 2014), discretionary grants (Crozet, Mayer, and Mucchielli, 2004; Devereux, Griffith, and Simpson, 2007; Bronzini and De Blasio, 2006), infrastructure investment (Kline and Moretti, 2014; Glaeser and Gottlieb, 2008; Becker, Egger, and Von Ehrlich, 2010), and community development (Eriksen and Rosenthal, 2010; Accetturo and De Blasio, 2012; Romero, 2009). This paper considers a large-scale place-based policy in a developing country. We are one of the first to discuss a paradox of the place-based policy when it can help the region but at the same time hurt the people from the region.

Second, our study is connected with the literature on spatial misallocation (Romero, 2009; Fajgelbaum et al., 2019; Hsieh and Klenow, 2009; Hsieh and Moretti, 2019). The most related studies are Yu (2019) and Fang and Huang (2020). Yu (2019) investigates the effect of the Farmland Red Line Policy on economic development in China. She finds that this restriction on converting rural farming land to urban construction land leads to severe land and labor misallocation, decreasing workers' welfare. Fang and Huang (2020) discuss land misallocation and its inequality implication in China. They find that as migration explodes, land supply in developed cities is far from enough, which causes the roaring housing costs. The increased housing costs benefit local housing owners and hurt migrants, which results in increased inequality. Our paper departs from the previous two studies in the sense that we are the first to investigate the important inland-favoring land supply policy and its effect on migration, productivity, and inequality in China.

Third, we are also connected with the literature on migration and regional development in China. Other scholars investigate the Hukou restriction and workers' migration (Tombe and Zhu, 2019; Hao et al., 2019), international trade and labor mobility (Ma and Tang, 2020; Tian, 2018; Fan, 2019; Zi, 2020), air quality (Khanna et al., 2021), and local public services for migrants (Sieg, Yoon, and Zhang, 2021; Huang, 2020). This study connects land misallocation and workers' domestic migration to examine the effect of an important place-based policy on the Chinese economy in terms of efficiency and equality.

2 Background and Data

2.1 Background

In China, agricultural land is owned collectively by the village, while urban land is state-owned. The ownership of agricultural land has to be transferred to the state through land expropriation before being used for urban construction. To ensure that there is enough agricultural land for domestic food supply, the central government places strict controls on expanding urban areas. Each city is assigned a quota of construction land usage in each year. However, rapid economic growth has led to a massive demand for urban land, especially in developed regions.

The allocation of construction land quotas has been used as a place-based policy since 2003. The National Master Land Use Plan (2006–2020) issued in 2008 states that the total construction land use in the coastal areas will be strictly controlled, and land-use quotas in the inland areas will be increased. Before 2003, developed areas with higher land demand were usually assigned more land quota. However, since 2003, the central government started to focused on balancing economic development by allocating more land quotas to under-developed inland provinces (Lu and Xiang, 2016; Han and Lu, 2017; Liang, Lu, and Zhang, 2016). In 2004, the Central Committee of the Chinese Communist Party made it clear that it is necessary to strengthen the role of land supply policy in macroeconomic management.[3]

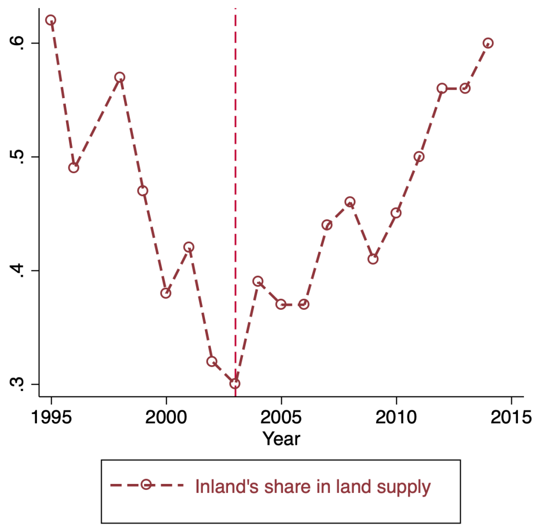
Figure 1 panel (a) shows that the inland provinces' share of the total land supply increased from less than 30% in 2003 to 60% in 2015. The turning point in 2003 is clear. Another policy change related to land supply is that, during 2003–2004, about 70% of existing development zones were closed. The planned land supply of those closed development zones was also cut. Most of the closed development zones were in the coastal region, and many newly opened development zones have since been established in the inland areas to support their local economic development (Lu and Xiang, 2016; Chen et al., 2019).

The trend of using land-use quotas as a inland-favoring place-based policy became even more apparent at the city level. Figure 1 panel (b) divides Chinese cities into two groups: one with the cities whose land-supply shares increased after 2003; the other with the cities whose land-supply shares shrank after 2003. The land supply in the first group was lower before 2003. While it surpassed the second group after 2003 and the gap was enlarged across time. Han and Lu (2017) also show that a city's land-supply share was more likely to shrink after 2003 if the city had a larger share of land supply before 2003. Those were usually eastern developed cities.

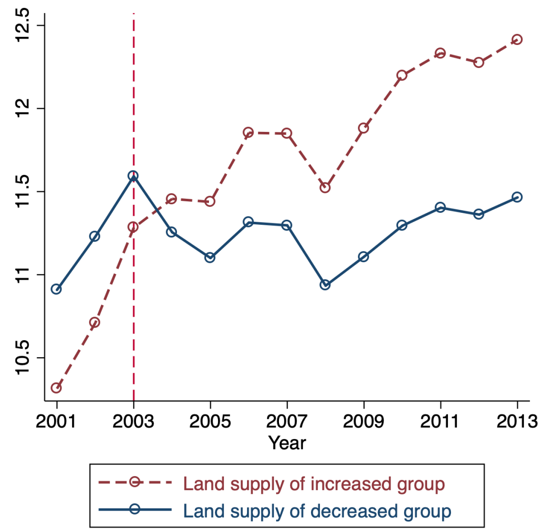
[3] Decision of the State Council on deepening the reform of strict land management, issued on 12/21/2004. Source: http://www.gov.cn/ztzl/2006-06/30/content_323794.htm.

Figure 1: The Inland-favoring Land Allocation Policy since 2003

(a) Inland Provinces' Share in Land Supply



(b) Persistent Divergence between City Groups



Notes: Data sources are National Bureau of Statistics of China, Statistical Yearbook of China's Land and Resources (2000–2016), and Yearbook of China's Land (1996–1999).

2.2 Data

2.2.1 Data for Empirical Analysis

The main dataset we use in the empirical part is the land transaction data from 1998 to 2014, collected from the China Land Market Website (http://www.landchina.com/). It includes unique land ID, parcel location, land usage (industrial land, commercial/service sector land, housing land, and other), land area, and leasing prices. The *Regulations on the Disposition of State-Owned Land Use Rights for Auctions and Biddings* requires that local land administration departments to publish the information on the transfer of state-owned land-use rights.

Panel A in Table 1 shows the descriptive statistics of the data. The enterprise information is from the National Industrial Enterprise Database, published by the National Bureau of Statistics. It covers all state-owned industrial enterprises and non-state-owned enterprises that are "above scale" (main business revenue greater than 5 million RMB). This dataset accounts for more that 90% of the industrial production. Since one of our major concerns is TFP, and there is a problem of missing data after 2007, we only use samples from 1998 to 2007. The database contains rich enterprise-level information, such as firm name, legal person code, four-digit industry category, starting year of business, employee number, salary, and total fixed assets.[4] Panel B in Table 1 shows the descriptive statistics of the data. TFP calculation is based on both OP (Olley and Pakes, 1992) and LP (Levinsohn and Petrin, 2003) estimation methods.

Table 1: Summary Statistics

Variable	Description	Observations	Mean	Std.dev.	Min	Max
Panel A: Land Parcel						
Ln (land price)	Ln (10000 Yuan per hectare)	445,689	5.09	2.36	-14.96	19.91
Area	Hectare	445,689	3.09	16.53	0.00005	6486
East	Dummy	445,689	0.607	0.49	0	1
Land Distance	Km	445,689	29.39	110.64	-199.99	199.99
Panel B: Industrial Enterprises						
Ln (tfp_op)	TFP (OP)	1,057,775	3.15	1.05	-0.038	5.63
Ln (tfp_lp)	TFP (LP)	1,058,102	6.30	1.12	3.08	9.02
Ln (output)	Ln (1000 yuan)	1,058,102	8.58	1.34	4.77	12.29
Ln (wage)	Ln (1000 yuan)	1,056,023	2.32	0.72	-7.82	11.23
Age	Year	1,058,102	10.26	9.86	1	48
Employee	Person	1,058,102	208.93	329.54	12	2300
East	Dummy	1,058,102	0.79	0.41	0	1
Firm Distance	Km	1,058,102	72.99	103.60	-199.99	199.99

Notes: Ln (land price) is the logarithmic land price, and land price is the leasing price per hectare. East is a dummy variable, set to 1 if the land parcel is in the eastern area. Land distance is the distance from the parcel to the east–inland provincial boundary, which is positive for the eastern land and negative for the western land. Firm distance is the distance from the firm's location to the east–inland provincial boundary, which is positive for the eastern land and negative for the western land. All chosen samples are within 200 km of the boundary.

2.2.2 Data for Spatial Equilibrium Model

For the model part of this study, the main dataset we use is the Chinese Population Census. It is the most comprehensive household survey in China. Every ten years, Chinese government will have a thorough investigation of all the households in the country, which is called the Census. All the families have to take a short survey, which requires them to provide basic demographic information such as name, age, gender, education, and living address. Among all the families, 10% of them will take a long survey. The questionnaire of the long survey includes additional information such as jobs and birth history. Between each decennial-Census, there is a mini-Census. The National Bureau of Statistics will randomly choose 10% of the population to take a survey which is similar to the long survey in the decennial-Census. For simplicity, we call both

[4] For unknown reasons, some companies provide missing or erroneous information. Therefore, we conducted a clean-up and a 1% censoring process to avoid abnormal observations.

decennial-Census and mini-Census, the Census. In this study, we use the Census data from 2005 and 2010. They give us city-sector-level migration flows and housing rents for individuals with different education levels. In total, we have 2,585,481 individuals in the year 2005, which covers 0.2% of the Chinese population. And we have 4,803,589 observations in the year 2010, which covers 0.36% of the population.

Besides the Census, we also utilize the City Statistic Yearbooks and the Urban Statistic Yearbook. The City Statistic Yearbooks are edited by local branches of the National Bureau of Statistics. Each city collects its data on city-level information and publish it in every year. We use the city-industry level wage information in these books to impute city-skill level wages. The basic idea is as follows. We know each individual's industry and skill from the Census data. We also get the average wages for each industry in each city from the City Statistic Yearbooks. Then we assign this average wage to each individual in the Census data based on their city and industry information, as the imputed individual wages. Then, we calculate the average wages in each city for each skill using these imputed wages. The detailed imputation method is identical to the one used in Fang and Huang (2020). We also derive city-level GDP growth and constructed land area data from the Urban Statistic Yearbook, which is a book with a summary of key characteristics in all Chinese cities.

3 Empirical Evidence

As we have mentioned in the previous section, urban land is totally owned by the state in China and government has the power to distribute the construction land quota to different places. In 2003, Chinese central government started its plan to allocate more land quota to under-developed non-eastern inland provinces (Lu and Xiang, 2016; Han and Lu, 2017; Liang, Lu, and Zhang, 2016). In this section, we show empirical facts that this place-based land allocation policy resulted in a relative increase in the land prices and a relative decrease in the TFP for firms in the eastern region.

3.1 RD-DID Specification

The empirical strategy we use is a combination of Border Regression Discontinuity Design (Black, 1999) and Difference-in-Difference (RD-DID). The basic idea is to first compare land parcels' prices on the eastern and the non-eastern side just at the border. Then we compare this price difference at border, before and after the year when the central government implemented the inland-favoring land supply policy. For land parcel i at border segment b in city c, year t, we have the following regression:

$$
\begin{aligned}
ln(y_{ibct}) = \alpha + \beta_1 East_{ibc} + \beta_2 f(Dist_{ibc}) + \beta_3 East_{ibc} \times f(Dist_{ibc}) \\
+ Post2003 \times [\delta_1 East_{ibc} + \delta_2 f(Dist_{ibc}) + \delta_3 East_{ibc} \times f(Dist_{ibc})] + \beta_4 X_{ct-1} + \phi_b + \gamma_t + \epsilon_{ibt}
\end{aligned}
\tag{1}
$$

y_{ibt} is the land price of parcel i. $East_{ib}$ is a dummy which equals 1 if the land parcel is located on the eastern side of the border. $f(Dist_{ib})$ is a smooth function of the distance between the land parcel and the border. $Post2003$ is a dummy which equals 1 if t is after 2003 (including 2003 itself)[5]. X_{ct-1} is a set of lagged city-level control variables, including the log of GDP, the log of population, the log of city area, and the scale of the service sector. ϕ_b is the border segment fixed effect. Here, we divide the border into five segments of equal length and designate each land parcel to the nearest segment.[6] γ_t is the year fixed effect.

This is a regression combining RD and DID method. First, we can consider the first three terms (except the intercept), that is, $\beta_1 East_{ibc} + \beta_2 f(Dist_{ibc}) + \beta_3 East_{ibc} \times f(Dist_{ibc})$. They consist of a border regression discontinuity design regression with the running variable to be the distance to border. Using the observations within a small bandwidth, we can assume that land parcels just on the eastern side of border b are very similar to land parcels just on the non-eastern side. By fitting a smooth function $f(Dist)$, we have β_1 to be the effect of being in the eastern region on outcome variable y. We use three fitting functions in this study, local linear regression, linear regression, and quadratic regression. The optimal bandwidth we use for local linear fit is based on Imbens and Kalyanaraman (2012). The bandwidth we use for linear and quadratic fit is 80 km.[7]

Second, we add in the interaction between the post 2003 dummy and all previous RD terms. Parameter δ_1 then denotes the policy effect. It can be interpreted as the difference between eastern region effects before and after the 2003 inland-favoring land allocation policy. Thus, this is a difference-in-difference estimation. The first difference is between the eastern and the non-eastern region (at the border, within the bandwidth). The second difference is between the before policy (2003) period and the after policy period. In general, this specification combines border regression discontinuity design with difference-in-difference method. In the main context, we

[5]We also run all regressions in a specification when 2003 is excluded from the treatment group. The results are not changed qualitatively.

[6]We also try specifications when we also control for city and province level fixed effects. The policy effect δ_1 does not change. The results are available upon request. The reason we do not use these two specifications in the main context is because city or province level fixed effects will absorb all variations at city or province level, which leads β_1 to be unidentified.

[7]We also try some other bandwidths, the results are similar. Please refer to Appendix A for details.

investigate two outcome variables. Except for land prices at land parcel-level, we also consider TFP at firm-level.[8]

3.2 Regression Assumptions Validation

3.2.1 Parallel Trend Assumption

One of the most important assumptions of any estimation involving DID method is the parallel trend. Figure 2 shows the time trends of three main outcome variables, including land prices, firm-level TFP calculated using LP method, and firm-level TFP calculated using OP method. The blue solid line is the average outcome value in the developed eastern region and the red dashed line is the value in the inland region, both of which are calculated within the bandwidth around the border. The dashed vertical line is put in the year of 2002, just before the implementation of the inland-favoring land policy. It is clear that all the outcome variables have very similar trends before the policy.

Furthermore, we implement a traditional event study regression to investigate the evolution of the eastern region effect across time. We take the year of 2002 as the baseline and then have the following regression:

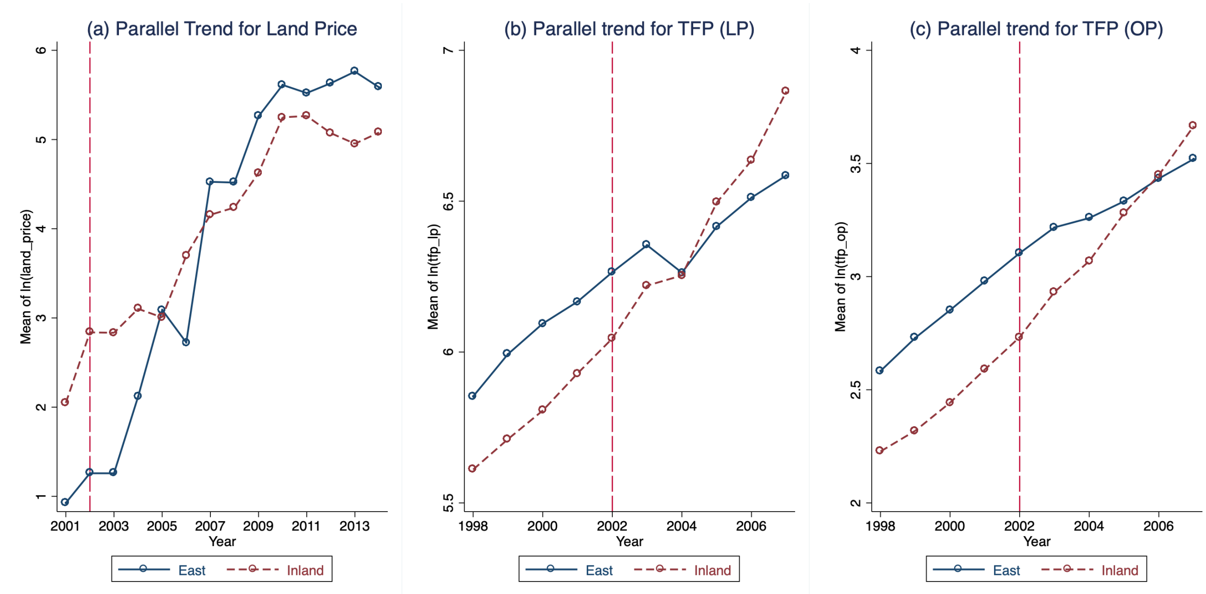
$$\begin{aligned} ln(y_{ibct}) = {} & \alpha + \beta_1 East_{ibc} + \beta_2 f(Dist_{ibc}) + \beta_3 East_{ibc} \times f(Dist_{ibc}) \\ & + \sum_{s \neq 2002} \mathbf{1}(s = t) \times [\delta_{1s} East_{ibc} + \delta_{2s} f(Dist_{ibc}) + \delta_{3s} East_{ibc} \times f(Dist_{ibc})] \\ & + \beta_4 X_{ct-1} + \phi_b + \gamma_t + \epsilon_{ibt} \end{aligned} \quad (2)$$

We plot the evolution of the coefficient δ_{1s} across time s in Figure 3, 4 and 5. These figures show the changes of the eastern region effect across time, with 90% confidence intervals. Four different regression settings are used. We choose smooth function to be either linear or quadratic. Meanwhile, we use either the raw border or thick border recommended in (Michalopoulos and Papaioannou, 2014).[9] In each figure, there are four subfigures, which refers to the four settings separately. It shows that all the coefficients are very close to zero before 2002. They become statistically and economically significant from zero only after the policy was implemented. The

[8] For regression of firm-level TFP, the meaning of subscript i then becomes each firm.

[9] Considering that provincial borders are generally mountains or rivers with special geographic characteristics, in this setting, we follow Michalopoulos and Papaioannou (2014) and remove land parcels within 10 km of both sides of the original provincial boundaries, thereby obtaining a "thick provincial border" and alleviating the effect of special landforms on land prices.

Figure 2: Parallel Trend of Outcome Variables



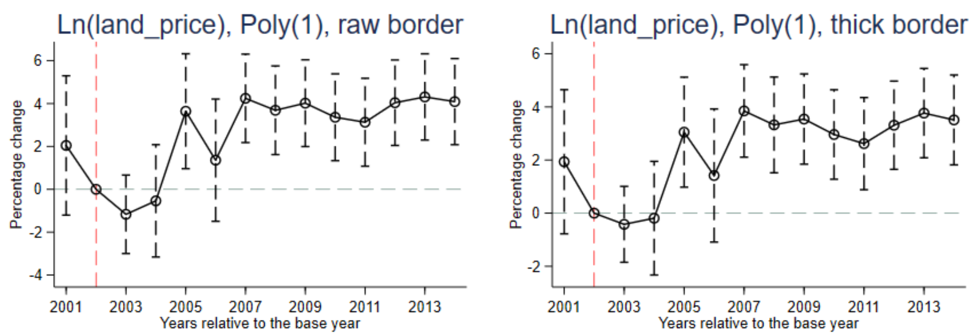
Notes: This figure shows the time trends of three main outcome variables, including land prices, firm-level TFP calculated using LP method, and firm-level TFP calculated using OP method. The blue solid line is the average outcome value in the developed eastern region and the red dashed line is the value in the inland region, both of which are calculated within the bandwidth around the border. The dashed vertical line is put in the year of 2002, just before the implementation of the inland-favoring land policy. It is clear that all the outcome variables have very similar trends before the policy.

results from this event study confirm the fact that there is no pre-trend in our data. These figures also give us a first look of the main results. We can see that, after the central government imposed the inland-favoring land policy in 2003, there was a relative increase in the land price in eastern region. Meanwhile, the policy also relatively decreased the firm productivity in eastern region. We will have more detailed discussions in the next section.

3.2.2 RDD Assumptions

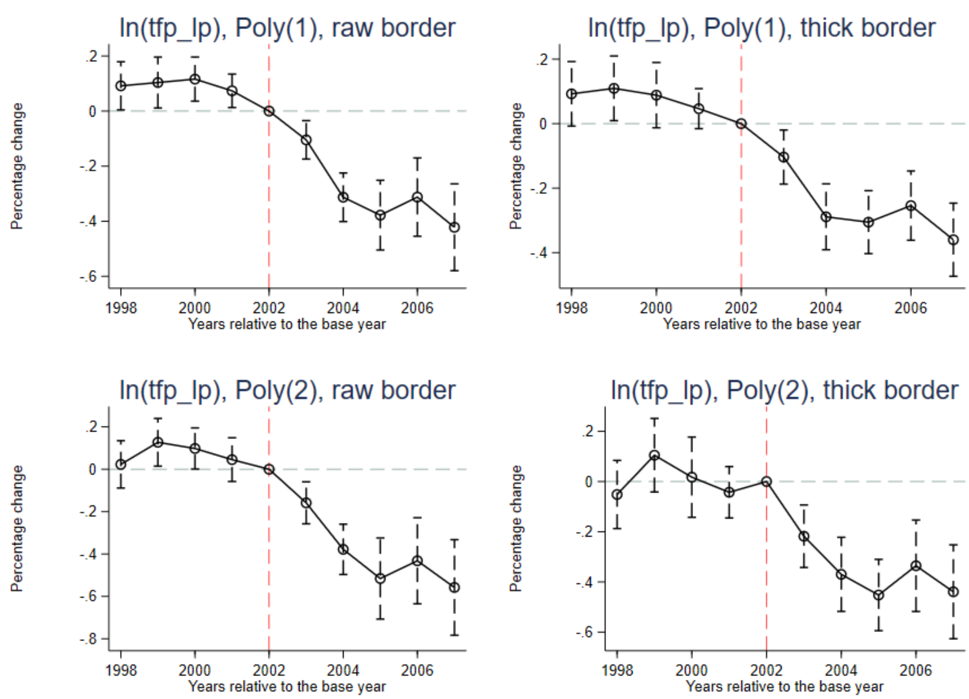
Apart from the parallel trend assumption, there is another RD-related assumption we need to impose in our RD-DID specification. We assume that there is no manipulation of land selling and the land parcels around the border are comparable. Although the land quota is set by the central government, local governments are responsible for choosing which piece of land to develop and sell. Thus, they may deliberately develop land with specific characteristics, either observed or unobserved by econometricians. For example, non-eastern government may choose to develop all of their land at the border for some reason while eastern government may not. If this manip-

Figure 3: Event Study - Land Price



Notes: The dependent variable is the land parcel-level price. We only show the results for the linear fitting function since we do not have enough observations before 2003 for quadratic fitting function. As we add in high order polynomials, the behavior of the fitting becomes weired, which indicates a typical overfitting and boundary problem. The bandwidth is 80km. The confidence interval is 90%.

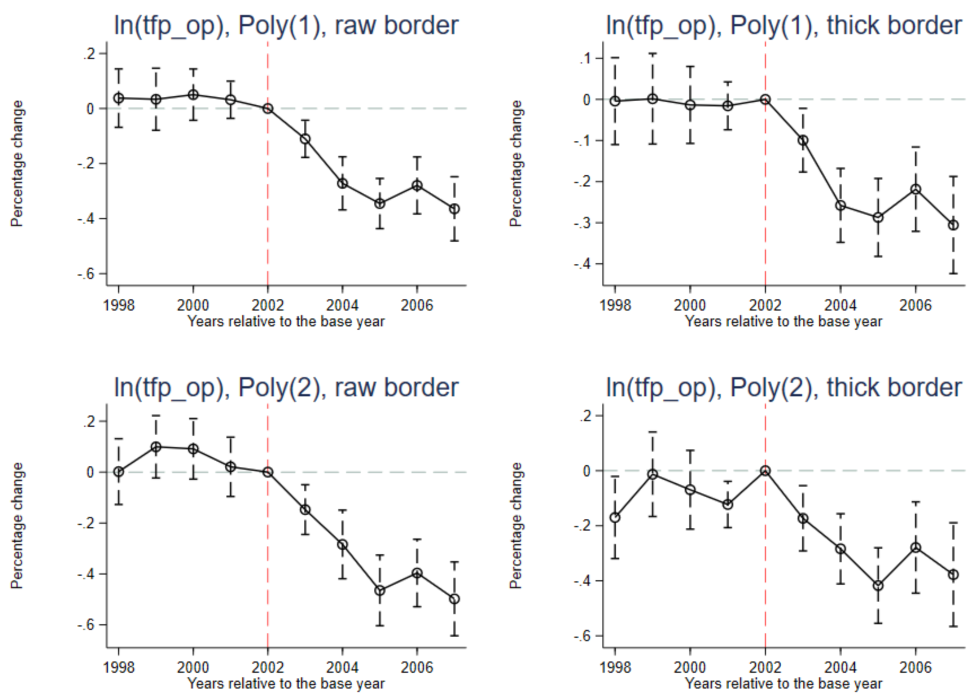
Figure 4: Event Study - TFP (LP)



Notes: The dependent variable is the firm-level TFP calculated by LP method. The bandwidth is 80 km from the border of eastern and non-eastern classification. The confidence interval is 90%.

ulation is true, we may not be able to assume that the land parcels just on the eastern side of the border are similar to the ones just on the non-eastern side. Figure 6 shows the distribution of the

Figure 5: Event Study - TFP (OP)



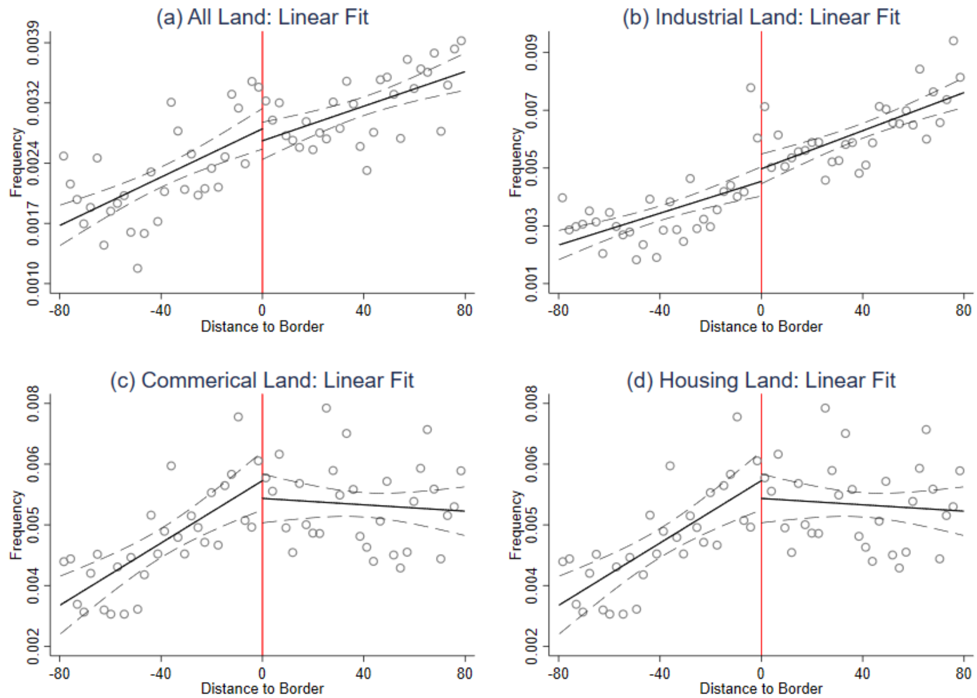
Notes: The dependent variable is the firm-level TFP calculated by OP method. The bandwidth is 80 km from the border of eastern and non-eastern classification. The confidence interval is 90%.

sold land parcels. We also separate the figures by their usage. It illustrates that for all kinds of land parcels, there is no evidence of discontinuity in their distribution at the border. Similarly, Table 2 shows the balance of some pre-determined land parcel characteristics, including elevation, slope and ruggedness. We test whether there is any jump of these covariates at the border by running different RD regressions. The results do not show any evidence of jumps of these pre-determined covariates. Thus, the land parcels at the border are comparable.

3.3 RD-DID Results

Table 3 shows the RD-DID regression results when we use the log of land prices as the outcome variable. The first two columns illustrate the results when we use local linear smooth function. The third and fourth columns illustrate the results when we use first order (linear) polynomial smooth function. The last two columns illustrate the results when we use second order (quadratic) polynomial smooth function. In general, we can see that before the inland-favoring land supply policy was imposed, eastern region had about 3.0-9.2% lower land prices. However, the policy

Figure 6: Distribution of Land Parcels



Notes: The dependent variable is the land parcel frequency. The bandwidth is 80 km from the border of eastern and non-eastern areas.

totally eliminated the price gap. The reduction in the construction land quota after 2003 led to approximately 3.3-9.4% increase in the land prices in eastern developed region.

Table 4 and 5 show the regression results when we use the log of firm-level TFP as the outcome variable. When we use LP method to calculate the TFP, we find that before the policy, eastern firms generally had 0.27-0.42% higher TFP than non-eastern firms. However, the reduction in the construction land supply after 2003, reduced the relative TFP of eastern firms by 0.34-0.55%. The results are very similar when we use OP method to calculate the TFP. In addition to TFP, we also run the same regressions for firm-level output, average wages, and return on asset. They all show the same pattern that the inland-favoring land policy decreased the relative output, wages and return on asset in the eastern region. The detailed results are available upon request.

3.4 Remarks on Empirical Results

Generally speaking, in the empirical part, we have two main findings. First, the inland-favoring land supply policy reduced the land supply and increased the land prices in the developed eastern

Table 2: Balance Check

	(1) Elevation	(2) Slope	(3) Terrain Ruggedness
	Panel A: Local Linear Regression		
East	8.762	-0.165	-5.413
	(30.015)	(0.217)	(7.130)
Border FE	Yes	Yes	Yes
Observations	2766	3088	3684
	Panel B: Polynomial RD (Poly=1)		
East	-18.943	0.140	4.852
	(17.796)	(0.152)	(5.015)
Border FE	Yes	Yes	Yes
Observations	8498	8506	8498
	Panel C: Polynomial RD (Poly=2)		
East	5.553	-0.191	-4.719
	(25.162)	(0.210)	(7.008)
Border FE	Yes	Yes	Yes
Observations	8498	8506	8498

Notes: Unit of observation: 10 km × 10 km grid. Sample in local linear regression specification is restricted to be within an optimal bandwidth using a constant kernel. Sample in Local linear regression specification is restricted to be within an optimal bandwidth using a constant kernel. Sample in Polynomial RD is restricted to be within a bandwidth of 80 km around the raw boundary. Standard errors in parentheses are clustered at the 1 km interval level in regressions with polynomials in distance. Data source: elevation comes from the US Geological Survey Center (`http://www.webgis.com/srtm30.html`). Slope and terrain ruggedness index come from Nunn and Puga (2012), `https://diegopuga.org/data/rugged/#grid`
*** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.

region relative to the non-eastern region. Second, the inland-favoring land supply policy also decreased the relative firm productivity in the eastern region. In Appendix A, we implement more robustness checks to validate our empirical findings. The results show that the conclusions are maintained in different specifications.

We claim that although government achieved the goal to shrink the productivity gap between eastern and non-eastern regions, we have to pay a huge cost. In the eastern region, when land prices are increased, residential cost will be increased for workers and production land cost will also be increased for firms. Then firms and workers may relocate themselves to other places with lower cost and leave the developed region with higher productivity. This can lead to a loss in terms of the national TFP and output. The inequality may also increase rather than decrease since the policy prevent many workers from under-developed areas from migrating to developed

Table 3: RD-DID Results on Land Prices

	Local Linear		Polynomial RD (Poly=1)		Polynomial RD (Poly=2)	
	Raw Border	Thick Border	Raw Border	Thick Border	Raw Border	Thick Border
	(1)	(2)	(3)	(4)	(5)	(6)
East	-5.128***	-9.189**	-3.371***	-2.964***	-4.540	-5.341***
	(1.442)	(3.538)	(1.167)	(0.957)	(2.748)	(1.761)
Post2003×East	5.270***	9.446**	3.660***	3.279***	4.658*	5.557***
	(1.434)	(3.538)	(1.161)	(0.951)	(2.733)	(1.775)
City Lagged Controls	Y	Y	Y	Y	Y	Y
Border FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Observations	128294	55654	169339	154990	169339	154990
Adjusted R-squared	0.060	0.070	0.055	0.054	0.056	0.055

Notes: The dependent variable is the land parcel-level price. The set of lagged city level control variables includes the log of GDP, the log of population, the log of city area, and the scale of the service sector. Sample in Local linear regression specification is restricted to be within an optimal bandwidth using a constant kernel. Sample in Polynomial RD is restricted to be within a bandwidth of 80 km around the raw boundary. *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.

cities with higher wages. Thus, the policy may hurt the people it intended to help. We will explain this mechanism in more details in the next few sections using a spatial equilibrium model. We will also simulate a counterfactual if the land allocation rule was not changed in 2003 and show how much we can gain from distributing more land quotas to places with higher productivity and land demand in terms of not only efficiency, but also equality.

Table 4: RD-DID Results on TFP (LP)

	Local Linear		Polynomial RD (Poly=1)		Polynomial RD (Poly=2)	
	Raw Border (1)	Thick Border (2)	Raw Border (3)	Thick Border (4)	Raw Border (5)	Thick Border (6)
East	0.359***	0.272***	0.420***	0.379***	0.392***	0.366***
	(0.077)	(0.083)	(0.051)	(0.051)	(0.064)	(0.074)
Post2003×East	-0.551***	-0.353***	-0.405***	-0.344***	-0.498***	-0.380***
	(0.095)	(0.087)	(0.066)	(0.050)	(0.084)	(0.079)
City Lagged Controls	Y	Y	Y	Y	Y	Y
Border FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Observations	71168	52299	281718	253850	281718	253850
Adjusted R-squared	0.100	0.107	0.092	0.093	0.093	0.093

Notes: The dependent variable is the firm-level TFP measured by LP method. The set of lagged city level control variables includes the log of GDP, the log of population, the log of city area, and the scale of the service sector. Sample in Local linear regression specification is restricted to be within an optimal bandwidth using a constant kernel. Sample in Polynomial RD is restricted to be within a bandwidth of 80 km around the raw boundary. *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.

Table 5: RD-DID Results on TFP (OP)

	Local Linear		Polynomial RD (Poly=1)		Polynomial RD (Poly=2)	
	Raw Border (1)	Thick Border (2)	Raw Border (3)	Thick Border (4)	Raw Border (5)	Thick Border (6)
East	0.512***	0.391***	0.411***	0.351***	0.473***	0.338***
	(0.086)	(0.072)	(0.045)	(0.050)	(0.054)	(0.073)
Post2003×East	-0.492***	-0.262**	-0.324***	-0.240***	-0.428***	-0.244***
	(0.071)	(0.100)	(0.054)	(0.050)	(0.061)	(0.081)
City Lagged Controls	Y	Y	Y	Y	Y	Y
Border FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Observations	46688	48991	281718	253850	281718	253850
Adjusted R-squared	0.174	0.165	0.151	0.151	0.152	0.151

Notes: The dependent variable is the firm-level TFP measured by OP method. The set of lagged city level control variables includes the log of GDP, the log of population, the log of city area, and the scale of the service sector. Sample in Local linear regression specification is restricted to be within an optimal bandwidth using a constant kernel. Sample in Polynomial RD is restricted to be within a bandwidth of 80 km around the raw boundary. *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.

4 The Model

The economy consists of a set of discrete locations, more specifically in this paper, **cities**, which are indexed by $i = 1, ..., K$. Each city j consists of two sectors: urban u and rural r. The economy is populated by an exogenous measure of H workers, who are imperfectly mobile within the economy subject to migration costs. Each worker is either low skill $s = l$ or high skill $s = h$. Each location i has an effective supply of urban floor space S_i^u which is produced by a fixed amount of land supply L_i^u of the urban region. In urban areas, floor space can be used for both production and residence, and we denote the endogenous fractions of floor space allocated to production and residential use by θ_i and $(1 - \theta_i)$, respectively. The housing market in rural areas is simple such that the rent is proportional to the average rent in urban areas in the same city.[10]

Workers decide whether or not to move after observing idiosyncratic utility shocks between each possible pair of destination location and their original location. Firms produce a single final good, which is costlessly traded within the country, and is chosen as the numeraire. Locations differ in terms of their urban final goods productivity (A_i^u), rural final goods productivity (A_i^r), and supply of floor space in urban region (S_i^u).

4.1 Worker Preferences

Utility of worker o with skill s, originated from region i sector n, migrating to region j sector k is a combination of final good consumption ($c^o_{in,jk}$), residential floor space consumption ($s^o_{in,jk}$), migration costs ($\tau^s_{in,jk}$), and an idiosyncratic shock ($z^o_{in,jk}$) in a Cobb-Douglas form:

$$U^o_{in,jk} = \frac{z^o_{in,jk}}{\tau^s_{in,jk}} \left(\frac{c^o_{in,jk}}{\beta} \right)^{\beta} \left(\frac{s^o_{in,jk}}{1 - \beta} \right)^{1-\beta} \tag{3}$$

We model the heterogeneity in the utility that workers derive from working in different parts of the economy following Eaton and Kortum (2002). We also do not distinguish the utility function forms of urban residence and rural residence, but allow rural workers to construct their own residential floor space with construction costs. For each worker o originated from region i sector n, migrating to region j sector k, the idiosyncratic component of utility ($z^o_{in,jk}$) is drawn from an

[10] This model setting reflects a special land distribution system in rural China. All lands in rural China are owned by the village collectively, but not by individual. There is no housing market in the rural area. The village council first distributes land to farmers (housing land, or in Chinese, *Zhaijidi*), then farmers build their houses by themselves. They cannot sell or buy any houses. Thus, the housing cost for them is basically building cost.

independent Fréchet distribution:

$$F(z^o_{in,jk}) = e^{-{z^o_{in,jk}}^{-\epsilon}},\ \epsilon > 1$$

where the shape parameter $\epsilon > 1$ controls the dispersion of idiosyncratic utility. We assume that the migration costs can be separated into two parts:

$$\tau^s_{in,jk} = \bar{\tau}^s_{in} d_{in,jk}$$

where $d_{in,jk}$ captures the physical distance and institutional cost, due to the Hukou system and other potential frictions, in migrating from city i sector n to city j sector k; and $\bar{\tau}^s_{in}$ captures the difference of the cost across individuals with different skills which may include skill-biased migration policies, and differences in their preferences for specific types of amenities such as education for children, entertainments, and transportation.

After observing the realizations of idiosyncratic utility for each pair between their origination and potential employment location, each worker chooses his/her location and sector of employment to maximize his/her utility, taking as given residential amenities, goods prices, factor prices, and decisions of other workers and firms. Each worker is endowed with one unit of labor that is supplied inelastically with zero disutility. Combining our choice of the final good as numeraire with the first-order conditions for consumer equilibrium, we obtain the following demands for the final good and residential floor space for worker o with skill s from location i sector n and migrate to location j sector k:

$$c^o_{in,jk} = \beta v^s_{in,jk} \tag{4}$$

$$s^o_{in,jk} = (1-\beta)\frac{v^s_{in,jk}}{Q_{jk}} \tag{5}$$

where $v^s_{in,jk}$ is the total income for a worker with skill s who stays in sector k, including wage income and return from owning floor space in worker's Hukou place (city-sector) in. Q_{jk} is the rent of the residential floor space in sector k in city j.

Floor space is not tradable and is owned in common by local residents. This assumption is broadly consistent with the institutional features of China, and implies that migrant workers have no claim to this fixed factor income. Therefore, the income $v^s_{in,jk}$ is a combination of wage income of skill s and equally-divided residential floor space rent income among local Hukou registers in location i sector n:

$$v^s_{in,jk} = w^s_{jk} + \frac{Q_{in}S^R_{in}}{H^R_{in}} \tag{6}$$

where H^R_{in} denotes all local Hukou registers including those who migrated out for working.

Substituting equilibrium consumption of the final good and residential land use into utility, we obtain the following expression for the indirect utility function:

$$U^o_{in,jk} = \frac{z^o_{in,jk} v^s_{in,jk} Q^{\beta-1}_{jk}}{\tau^s_{in,jk}} \tag{7}$$

4.2 Distribution of Utility and Migration Flow

Using the monotonic relationship between utility and the idiosyncratic shock, the distribution of utility for a worker from city i sector n and move to city j sector k is also Fréchet distributed:

$$G^s_{in,jk}(u) = Pr[U \leq u] = F\Big(\frac{u\tau^s_{in,jk} Q^{\beta-1}_{jk}}{v^s_{in,jk}}\Big) \tag{8}$$

$$G^s_{in,jk}(u) = e^{-\Phi^s_{in,jk} u^{-\epsilon}},\ \Phi^s_{in,jk} = (\tau^s_{in,jk} Q^{\beta-1}_{jk})^{-\epsilon}(v^s_{in,jk})^{\epsilon} \tag{9}$$

Since the maximum of a sequence of Fréchet distributed random variables is itself Fréchet distributed, the distribution of utility across all possible destinations is

$$1 - G^s_{in}(u) = 1 - \prod_{jk=11}^{JK} e^{-\Phi^s_{in,jk} u^{-\epsilon}} \tag{10}$$

Therefore we have

$$G^s_{in}(u) = e^{-\Phi^s_{in} u^{-\epsilon}},\ \Phi^s_{in} = \sum_{jk=11}^{JK} \Phi^s_{in,jk} \tag{11}$$

Let $\pi^s_{in,jk}$ denote the share of workers with skill s registered in in who migrated to jk. The law of large numbers implies that the proportion of workers who migrate to region jk is

$$\pi^s_{in,jk} = \frac{(\tau^s_{in,jk} Q^{\beta-1}_{jk})^{-\epsilon}(v^s_{in,jk})^{\epsilon}}{\sum_{j'k'=11}^{JK}((\tau^s_{in,j'k'} Q^{\beta-1}_{j'k'})^{-\epsilon}(v^s_{in,j'k'})^{\epsilon})} = \frac{\Phi^s_{in,jk}}{\Phi^s_{in}} \tag{12}$$

This is a typical gravity equation in spatial equilibrium models.

4.3 Production

We assume that there is a single final good y that is costlessly traded within the economy. In urban regions, it is produced with constant returns to scale in a Cobb-Douglas form, using efficient labor combination X_j, and production floor space S_j^M:

$$Y_{ju} = (X_{ju})^{\alpha}(S_{ju}^M)^{1-\alpha}, \text{ where } X_{ju} = [(A_{ju}^h H_{ju}^h)^{\frac{\sigma-1}{\sigma}} + (A_{ju}^l H_{ju}^l)^{\frac{\sigma-1}{\sigma}}]^{\frac{\sigma}{\sigma-1}} \tag{13}$$

where X_{ju} is a CES combination of efficient high skill labor H_{ju}^h and low skill labor H_{ju}^l multiplied by their corresponding city-level efficiency A_{ju}^h and A_{ju}^l respectively. In rural regions, the production is simply $Y_{jr} = A_{jr}H_{jr}$. Since we are not focusing on trade and substitutions between agricultural goods and other goods, we simply assume that Y_r and Y_u are perfect substitutes. In the equilibrium, A_{jr} equals the wage return of agricultural sector w_{jr} in city j rural sector r.[11]

Firm Optimization: We assume that the goods market is perfectly competitive. Urban firms choose their inputs of workers and production floor space to maximize profits, taking as given final goods productivity ($\{A_{ju}^h, A_{ju}^l\}$), the distribution of idiosyncratic utility, factor prices, and decisions of other firms and workers. From the first-order conditions, we obtain:

$$w_{ju}^l = \alpha X_{ju}^{\alpha-1} S_{ju}^{M\,1-\alpha} A_{ju}^{l\,\frac{\sigma-1}{\sigma}} X_{ju}^{\frac{1}{\sigma}} H_{ju}^{l\,-\frac{1}{\sigma}} \tag{14}$$

$$w_{ju}^h = \alpha X_{ju}^{\alpha-1} S_{ju}^{M\,1-\alpha} A_{ju}^{h\,\frac{\sigma-1}{\sigma}} X_{ju}^{\frac{1}{\sigma}} H_{ju}^{h\,-\frac{1}{\sigma}} \tag{15}$$

$$S_{ju}^M = \left(\frac{1-\alpha}{q_{ju}}\right)^{\frac{1}{\alpha}} X_{ju} \tag{16}$$

This also given us a measure of skill premium ω of city j:

$$\omega_{ju} = \frac{w_{ju}^h}{w_{ju}^l} = \left(\frac{A_{ju}^h}{A_{ju}^l}\right)^{\frac{\sigma-1}{\sigma}} \left(\frac{H_{ju}^h}{H_{ju}^l}\right)^{-\frac{1}{\sigma}} \tag{17}$$

To determine the equilibrium production floor price, q_j , we use the requirement that profits are zero:

$$(X_{ju})^{\alpha}(S_{ju}^M)^{1-\alpha} - W_{ju}X_{ju} - q_{ju}S_{ju}^M = 0$$

where $W_{ju}X_{ju} = w_{ju}^l H_{ju}^l + w_{ju}^h H_{ju}^h$. This together with profit maximization (16) yields the following expression for the equilibrium production floor price:

$$q_{ju} = (1-\alpha)\left(\frac{\alpha}{W_{ju}}\right)^{\frac{\alpha}{1-\alpha}} \tag{18}$$

[11] We make a simplification such that $w_{jr}^h = w_{jr}^l = w_{jr}$.

4.4 Land Market Clearing

4.4.1 Land Market Clearing in Urban Areas

Urban land market equilibrium requires a no-arbitrage condition between production and residential land use after taking into account the tax equivalent of land use regulations:

$$q_{ju} = \eta_j Q_{ju} \tag{19}$$

where η_j captures the land use regulations that restrict production land price relative to residential land price. Let θ_i be the proportion of floor spaces allocated to production use over residential use. We assume that $\theta_i \in (0, 1)$. Because production requires both production land and labor, and there is no commuting to work across cities, a city cannot have 100% production or 100% residential land.

Production land market clearing requires that the demand of production floor space equals the supply of floor space allocated to production use in each location: $\theta_j S_{ju}$. Using the first-order conditions for profit maximization, this production land market clearing condition can be written as:

$$S_{ju}^M = \left(\frac{(1-\alpha)}{q_{ju}}\right)^{\frac{1}{\alpha}} X_{ju} = \theta_j S_{ju} \tag{20}$$

Residential land market clearing implies that the demand of residential floor space equals the supply of floor space allocated to residential use in each location: $(1-\theta_j)S_j$. Using utility maximization for each worker and taking expectations over the distribution for idiosyncratic utility, this residential land market clearing condition can be expressed as:

$$S_{ju}^R = E[s_{ju}]H_{ju} = (1-\beta)\frac{E[v_{ju}]H_j}{Q_{ju}} = (1-\theta_j)S_{ju} \tag{21}$$

We assume that floor space S is supplied by a highly-regulated construction sector that uses geographic land L and regulated plot ratio ϕ_j as guidance to produce:

$$S_{ju} = \phi_j L_j \tag{22}$$

where ϕ_j determines the density of development (the ratio of floor space to land).

4.4.2 Land Market Clearing in Rural Areas

The housing market in rural area is simpler where there is no production land. We assume that the rural housing cost is a discounted cost relative to the urban cost:

$$Q_{jr} = \tau Q_{ju} \tag{23}$$

The price Q_{jr} is the cost of building a unit of house on farmers' housing land. Given the cost, rural residence choose the optimal floor space to build.

4.5 Definition of Spatial General Equilibrium

We now define and characterize the properties of a spatial general equilibrium given the model's fixed parameters $\{\beta, \epsilon, \alpha, \sigma, \mu\}$.

*A **Spatial General Equilibrium** for this economy is defined by a set of of exogenous economic conditions $\{\tau^s_{in,jk}, A^s_j, \eta_j, \phi_j, L_j, H^s_{in}\}$, a list of endogenous prices $\{Q_{ju}, q_{ju}, w^s_{jk}\}$, quantities $\{v^s_{in,jk}, Y_{jk}, H^s_{jk}, S_{ju}\}$, and proportions $\{\pi^s_{in,jk}, \theta_j\}$ that solve firms' problem, workers' problem, floor space producers' problem, and market clearing such that:*

> *(i).**[Worker Optimization]** Taking the exogenous economic conditions $\{\tau^s_{in,jk}, A^s_{jk}\}$ and the aggregate prices $\{Q_{ju}, w^s_{jk}\}$ as given, workers' optimal choices of migration pins down the equilibrium labor supply in each city H^s_{jk} and the migration flow between each city pairs $\pi^s_{in,jk}$.*
>
> *(ii).**[Firm Optimization]** Taking the exogenous economic conditions $\{A^s_{jk}\}$ and the aggregate prices $\{q_{ju}, w^s_{jk}\}$ as given, firms' optimal choices of production pins down the equilibrium labor demand H^s_j, equilibrium production floor space demand $\theta_j S_{ju}$ in each city.*
>
> *(iv).**[Market Clearing]** For all cities, labor supply equals labor demand and floor space supply equals floor space demand. This pins down the equilibrium aggregate prices $\{Q_{ju}, q_{ju}, w^s_{jk}\}$, the equilibrium floor space S_{ju}, and the equilibrium output Y_{ju}.*

5 Quantitative Analysis

In this section, we solve the model, and quantify the unobserved fundamentals of the economy, using the Census data we have in 2005 and 2010.

5.1 Calibration

We fix a set of parameters. We first use some moments from various data sets to pin down share parameters in preference of workers (β), final good production (α), and floor space regulation (η). We then use the estimations of the elasticities from Fang and Huang (2020) for the city pair migration elasticity (ϵ).

We match $(1 - \beta)$ to the share of residential floor space cost in consumer expenditure, $(1 - \alpha)$ to the share of production floor space in firm costs, and $(\eta - 1)$ to the relative production land use costs compared with residential land. First, to match $(1 - \beta)$, we use average accommodation expenditure share of total consumption from the Urban Household Survey of China (UHS). The survey is conducted by the National Bureau of Statistics of China with a change in statistics standard in 2012. We believe the new standard is more realistic which gives us an average around 23% from 2013 to 2017[12]. Hence, we choose (β) to be 0.77. Second, to match $(1 - \alpha)$, we use the average land cost per unit of output . Unfortunately, there is no direct measure of land usage and costs available, therefore, we relay on the *Enterprise Surveys* of Chinese manufacturing firms conducted by world bank in 2005. Firms report their tax payments of land usage through which we could infer the costs. The mean across all the firms and cities are 12% per unit of output. Therefore, we choose the labor share of production (α) to be 0.88. Finally, to match $(\eta - 1)$, we need to compare the land use costs of production compared with residential. The government of each city may have different incentive to promote residential construction or production construction due to tax or development motivations. Therefore, we use the land price differences to match η_j for each city j. The land price differences in each city come from land transaction data in the China Land Market Website, which is also used in our empirical part. We define land used for both industrial and service sectors as production land.

The elasticity of substitution between H/L-skills (σ) is calibrated to be 1.4 (Katz and Murphy, 1992), which is widely used in the previous literature. The city pair migration elasticity (ϵ) is calibrated to be 1.9. Tombe and Zhu (2019) estimates at province-sector pair and ends with a number of 1.5. Fang and Huang (2020) show that the city pair migration elasticity is around 1.9. We choose the latter one since it is estimated in an almost identical model context of this study. Finally, the relative cost of rural housing (τ) is calculated using the relative rent paid by observed rural sector workers over corresponding rent paid by observed urban sector workers in each city

[12] According to the old statistical standard, the average housing expenditure share ranges from 11.7% in 2012 to 14.3% in 2002 which is very low because they did not include the converted rent costs of self-owned houses and apartments. From 2013, the converted rent costs of self-owned houses and apartments was added to housing costs which resulted in a range of 22.7% in 2017 to 23.3% in 2013. Within each of these two periods, we find that the average expenditure share is very stable across time.

in both Census 2005 and Census 2010. This gives us a number of 0.34.

Summary of Parameters: Below in Table 6 is a short summary table of our parameters of estimation.

Table 6: **Parameters**

Parameter	Description	Value
β	share of consumption in utility	0.77
α	share of labor in production	0.88
η_j	relative cost of production to residential land	city-specific
σ	elasticity of substitution between H/L-skills	1.4
ϵ	migration elasticity	1.9
τ	relative cost of rural housing	0.34

5.2 Solving the Model

Based on the data we have on the observed equilibrium allocation and prices $\{H^s_{jk}, \pi^s_{in,jk}, w^s_{jk}, Q_{jk}, q_{jk}\}$, we could calculate all the unobserved variables: productivity $\{A^l_{jk}, A^h_{jk}\}$, migration cost $(\tau^s_{in,jk})$, floor spaces $\{S^M_{ju}, S^R_{ju}, S^R_{jr}\}$, and construction density (ϕ_i) in both 2005 and 2010.

A. Productivity

From profit maximization and zero profits, we could infer productivity from the data of employment and wage. First, we solve productivity A^h_j as a function of A^l_j using first order conditions.

$$A^h_{ju} = A^l_{ju}\left(\frac{H^h_{ju}}{H^l_{ju}}\right)^{\frac{1}{\sigma-1}}\left(\frac{w^h_{ju}}{w^l_{ju}}\right)^{\frac{\sigma}{\sigma-1}} \tag{24}$$

Plug A^h_{ju} into the definition of X_{ju}, we have

$$X_{ju} = A^l_{ju}H^l_{ju}\left[\frac{w^h_{ju}H^h_{ju} + w^l_{ju}H^l_{ju}}{w^l_{ju}H^l_{ju}}\right]^{\frac{\sigma}{\sigma-1}} \equiv A^l_{ju}H^l_{ju}(\Xi^l_{ju})^{-\frac{\sigma}{\sigma-1}} \tag{25}$$

where $\Xi^l_{ju} = \frac{w^l_{ju}H^l_{ju}}{w^h_{ju}H^h_{ju}+w^l_{ju}H^l_{ju}}$ is the share of labor income distributed to low skill workers. Also agricultural productivity equals to agricultural wage by assumption,

$$A^s_{jr} = w_{jr}, \quad \textit{for both } s = \{h, l\} \tag{26}$$

Combining the previous equation to the definition of W_{ju}, we have

$$W_{ju} = \frac{w^h_{ju}H^h_{ju} + w^l_{ju}Hu^l_{ju}}{X_{ju}} = \frac{w^l_{ju}}{A^l_{ju}}(\Xi^l_{ju})^{\frac{1}{\sigma-1}} \tag{27}$$

Plug W_j into the price function of q_j, we solve

$$A^l_{ju} = \frac{q_{ju}^{\frac{1-\alpha}{\alpha}} w^l_{ju}(\Xi^l_{ju})^{\frac{1}{\sigma-1}}}{\alpha(1-\alpha)^{\frac{1-\alpha}{\alpha}}} \tag{28}$$

We then have

$$A^h_{ju} = \frac{q_{ju}^{\frac{1-\alpha}{\alpha}} w^h_{ju}(\Xi^h_{ju})^{\frac{1}{\sigma-1}}}{\alpha(1-\alpha)^{\frac{1-\alpha}{\alpha}}} \tag{29}$$

where $\Xi^h_{ju} = 1 - \Xi^l_{ju}$. Intuitively, higher housing prices, higher wages, and higher share of total payroll of skill s require higher productivity of skill s at the equilibrium.

B. Land Market Clearing

From workers' first order conditions for residential floor space and the summation over all workers residing in each city j (residential demand) and the firms' first order conditions for production floor space, we could calculate both urban and rural floor space:

$$\begin{aligned}
S^R_{ju} &= E[s_{ju}]H_{ju} = (1-\beta)\frac{E[v_{ju}]H_{ju}}{Q_{ju}} \\
&= \frac{1-\beta}{Q_{ju}}\left[w^l_{ju}H^l_{ju} + w^h_{ju}H^h_{ju}\right] + (1-\beta)S^R_{ju} \\
&= \frac{1-\beta}{\beta Q_{ju}}\left[w^l_{ju}H^l_{ju} + w^h_{ju}H^h_{ju}\right] \\
S^M_{ju} &= \left(\frac{(1-\alpha)}{q_{ju}}\right)^{\frac{1}{\alpha}} X_{ju} \\
S^R_{jr} &= \frac{1-\beta}{\beta Q_{jr}}\left[w_{jr}H_{jr}\right]
\end{aligned} \tag{30}$$

we are then able to calculate the total amount of floor space S_j:

$$S_{ju} = S^R_{ju} + S^M_{ju} \tag{31}$$

and finally back out the construction intensity ϕ_j:

$$\phi_j = S_{ju}/L_j \tag{32}$$

C. Migration Costs

To compute migration costs, we need first to compute the city-level equally-divided rent income for local residents $\frac{Q_i S_i^R}{H_i}$ from the residential floor space S_i^R we calculated above. So we have the value of workers with skill s and sector n to move from i to j:

$$v_{in,jk}^s = w_{jk}^s + \frac{Q_{jn} S_{jn}^R}{H_{in}^R} \tag{33}$$

From gravity equations, we could calculate all the migration costs between all city pairs. We assume that the iceberg migration cost for staying in the original city is one, that is $\tau_{in,in}^s = 1$. With data Q_{in}, $v_{in,jk}^s$ and $\pi_{in,jk}^s$, and the gravity equation, we have:

$$\Phi_{in}^s = \sum_{jk=11}^{JK} (\tau_{in,jk}^s Q_{jk}^{1-\beta})^{-\epsilon} (v_{in,jk}^s)^{\epsilon} = \frac{(Q_{jk}^{1-\beta})^{-\epsilon} (v_{in,in}^s)^{\epsilon}}{\pi_{in,in}^s} \tag{34}$$

then by inserting Φ_i^s into the original gravity equation, we have:

$$\tau_{in,jk}^s = \frac{v_{in,jk}^s}{Q_{jk}^{1-\beta} (\pi_{in,jk}^s \Phi_{in}^s)^{1/\epsilon}} \text{ , for } i \neq j \tag{35}$$

for city-sector pairs with zero migration flows, we assign a migration probability $\pi_{in,jk}^s \sim 0$, resulting in a huge migration cost approaching infinite.

5.3 Measured TFP in the Model

Based on the model solution, we could calculate the measured total factor of productivity in the model. Different from the fundamental skill-augmented labor productivities A_{ju}^h and A_{ju}^l, measured TFP in neither Olley and Pakes (1992) nor Levinsohn and Petrin (2003) can take into consideration the land factor as one of the production inputs. Also, data for the costs of land input at firm-level is not available. In addition, the fundamental skill-augmented labor productivities A_{ju}^h and A_{ju}^l are not distinguishable in the data as well. Given all these limits, the measured urban

TFP in the model which matches the empirical part the best is

$$
\begin{aligned}
ln(\widetilde{TFP}_{ju}) =& ln\left(\frac{Y_{ju}}{(H^h_{ju}+H^l_{ju})^{\alpha}}\right) \\
=& ln\left(\frac{[(A^h_{ju}H^h_{ju})^{\frac{\sigma-1}{\sigma}}+(A^l_{ju}H^l_{ju})^{\frac{\sigma-1}{\sigma}}]^{\frac{\sigma}{\sigma-1}}}{(H^h_{ju}+H^l_{ju})^{\alpha}}\right)+(1-\alpha)ln(S^M_{ju}) \\
=& \underbrace{\frac{\sigma}{\sigma-1}ln(A^l_{ju})}_{\text{fundamental}}+\underbrace{\frac{\sigma}{\sigma-1}ln\left((\frac{A^h_{ju}}{A^l_{ju}}\Gamma^h_{ju})^{\frac{\sigma-1}{\sigma}}+(\Gamma^l_{ju})^{\frac{\sigma-1}{\sigma}}\right)}_{\text{skill premium}}+\underbrace{(1-\alpha)ln(H^h_{ju}+H^l_{ju})}_{\text{population scale premium}}+\underbrace{(1-\alpha)ln(S^M_{ju})}_{\text{land scale premium}}
\end{aligned}
\tag{36}
$$

where $\Gamma^h_{ju}=\frac{H^h_{ju}}{H^h_{ju}+H^l_{ju}}$ and $\Gamma^l_{ju}=1-\Gamma^h_{ju}=\frac{H^l_{ju}}{H^h_{ju}+H^l_{ju}}$ are the corresponding high-skill and low-skill labor shares. The decomposition shows that $ln(\widetilde{TFP}_{ju})$, the measured urban TFP in city j, could be decomposed into four components: fundamental low-skill labor productivity, skill premium of having higher share of high-skill workers (relative high-skill productivity), labor scale premium of having more working population, and land scale premium of having larger urban land.

Table 7 shows a summary of the model results of measured TFP and its decomposition following equation 36 by groups. There are four observations. First, the major difference in measured TFP across regions is in the fundamentals. Eastern and more developed cities have much higher fundamental productivity than non-eastern and less developed cities. Second, growth in measured TFP is mainly from the growth in fundamental productivity rather than other premiums. Third, eastern and more developed cities have higher population-scale premium and land scale premium due to relatively larger city size in both population and land. Fourth, however, eastern and more developed cities do not necessarily have higher skill premiums.

We calculate the national-level TFP as the weighted average of city-level TFP, with the number of workers as the weights. Using this decomposition result, we can investigate the changes in the national-level TFP by moving a low-skill worker from a small city to a big city. First, the fundamental term will increase since this worker goes to a big city with higher low-skill productivity. Second, the change in the PSP and LSP parts is negative. These two terms are concave functions of H and S, respectively, which means the marginal increment in big cities would be smaller to the marginal deduction in small cities when one worker migrates to a big city. However, the fundamental term dominates the other parts in terms of magnitude, making it clear that having more workers in big cities can increase the national weighted TFP.

Table 7: **Summary of Measured TFP in the Model**

Regions	No. of	2005					2010				
(location, development)	Cities	Total	Fund	SP	PSP	LSP	Total	Fund	SP	PSP	LSP
National	225	39.91	35.31	0.66	1.75	2.19	42.21	37.52	0.70	1.77	2.22
(eastern, high)	8	42.02	37.28	0.62	1.86	2.26	43.96	39.29	0.50	1.90	2.29
(eastern, mid)	28	40.95	36.07	0.73	1.86	2.28	42.64	37.61	0.91	1.84	2.28
(eastern, low)	61	39.03	34.68	0.53	1.67	2.15	41.72	37.28	0.55	1.71	2.19
(non-eastern, mid)	9	39.39	34.83	0.83	1.65	2.08	41.76	37.04	0.88	1.71	2.13
(non-eastern low)	119	38.48	34.06	0.69	1.63	2.10	41.41	36.87	0.70	1.69	2.16

Notes: This table displays a summary of measured TFP $ln(\widetilde{TFP}_{ju})$ in the model by group (weighted by population) in 2005 and 2010 as well as its decomposition: Fund stands for fundamental, SP stands for skill premium, PSP stands for population scale premium, and LSP stands for land scale premium. Regions are classified by the location of the city (east or non-east) and the level of development (GDP per capita) in 2005 as in the data. For the level of development, we equally divide all cities into three categories (high, mid, and low), based on their GDP per capita. Since there is no "high" development city in non-eastern region, we only have 5 groups in total. Each region consists of the same cities in both 2005 and 2010 for overtime comparison consistency.

5.4 Spatial Distribution of Land Tightness

As discussed in the empirical section, the inland-favoring land allocation policy potentially constrains the land supply in eastern and more developed cities. Now, we show how the spatial distribution of land tightness is in our model. We measure the across-city difference in land tightness using land per thousand workers and the within-city difference in land tightness using the relative price of production floor space over residential floor space.

The distribution is presented in Table 8. The across-city difference in land tightness measure shows that eastern and more developed cities have much higher and increasing land tightness in the land-worker ratio, which matches the trend we show in Figure 1. Comparing to non-eastern and less developed cities, eastern and more developed cities have on average 30% to 50% lower land-worker ratios. The within-city difference in land tightness measure shows that eastern and more developed cities have much higher and increasing land tightness in the price of production land relative to residential land. Comparing to non-eastern cities with low development levels, eastern and more developed cities have on average 15% to 80% higher price of production land relative to residential land.

Table 8: **Spatial Distribution of Land Tightness**

Regions (location, development)	No. of Cities	Land/Worker (km^2/k) 2005	2010	Prod./Resid. (q_{ju}/Q_{ju}) 2005	2010
National	225	0.093	0.083	0.99	0.96
(eastern, high)	8	0.072	0.062	1.53	1.42
(eastern, mid)	28	0.082	0.084	0.98	0.98
(eastern, low)	61	0.083	0.076	0.79	0.79
(non-eastern, mid)	9	0.127	0.117	1.02	1.04
(non-eastern, low)	119	0.121	0.092	0.85	0.85

Notes: This table displays a summary of total urban land supply data by group (weighted by urban population) in 2005 and 2010, as well as the counterfactual migration-based land supply in 2005 and 2010 (unit: km^2/k). Regions are classified by the location of the city (east or non-east) and the level of development (GDP per capita) in 2005 as in the data. For the level of development, we equally divide all cities into three categories (high, mid, and low), based on their GDP per capita. Since there is no "high" development city in non-eastern region, we only have 5 groups in total. Each region consists of the same cities in both 2005 and 2010 for overtime comparison consistency.

5.5 Remarks on Model Quantitative

These patterns in measured TFP and spatial distribution of land tightness indicate that there are potential productivity and equality gains if we reallocate land from non-eastern and less developed cities to eastern and more developed cities. Since eastern and more developed cities are much higher in fundamental productivity, such land reallocation would attract more workers to migrate to developed cities with higher wages and generate much higher national average fundamental productivity.

6 Eliminating the Inland-favoring Land Policy

In this section, we simulate counterfactual land allocation policies to alleviate land supply distortions. In this counterfactual world, we assume that the inland-favoring land supply policy was not implemented and the pre-2003 land allocation rule was maintained. Then, we investigate the effect of removing inland-favoring policy on workers' migration, land markets in different regions, TFP measures, and income inequality. We develop an iteration algorithm based on Fang and Huang (2020) to compute the counterfactuals. The details of the algorithm are shown in appendix B.

6.1 Constructing the Counterfactual Policy

We investigate what would have happened if the inland-favoring land supply policy after 2003 was not implemented. To do so, we keep the total land quota increments from 2003 to 2005 and 2010 unchanged, but redistributing the total land supply increment based on the land supply growth rate from 2000 to 2003.[13]

$$\widehat{L_j(t)} = L_j(2003) + \underbrace{\sum_j [L_j(t) - L_j(2003)]}_{\text{actual total increment of land}} \times \underbrace{\frac{L_j(2003)(1+g_{L_j})^{t-2003}}{\sum_j L_j(2003)(1+g_{L_j})^{t-2003}}}_{\text{city j's share if no inland-favoring}} \tag{37}$$

where the first component $L_j(2003)$ is city j's urban land stock in 2003 just before the structural change happened. The second component is a multiplication of the actual total increment of land $\sum_j [L_j(t) - L_j(2003)]$ in the whole nation and city j's share of land supply if the total land supply follows the growth rate before 2003. We consider this constrained counterfactual policy because this policy still fulfills the central government's strict goal of controlling total urban land supply expansion. This policy counterfactual can simulate a path without the land allocation rule change in 2003, reflecting the empirical findings in Section 3.

Policy Summary: The counterfactual land allocation policy is summarised in Table 9 for total quantities of land supply and in Table 10 for relative measures of land supply. In Table 9 (10), column 3-5 (3-4) shows the land supply from the data in the real world, and column 6-7 (5-6) shows the land supply in the counterfactual world when we redistribute the land quota according to equation (37). In general, we find in Table 9 and 10 that if we keep the land allocation rule before 2003 (rather than implementing the inland-favoring policy), we redistribute more urban land to more developed cities and increase land per worker in those places, compared with the real world. For instance, land supply per thousand workers in eastern cities with high productivity increases from 0.062 to 0.079 in 2010. Meanwhile, it decreases from 0.092 to 0.079 in non-eastern cities with low productivity in the same year.

6.2 Effects on Economic Development

We show the effects of this counterfactual policy on economic development in population, output, and measured TFP in this subsection.

Table 11 illustrates some significant counterfactual outcome changes compared with the real

[13] We cannot easily date back to pre-1999 because land supply data at the city level is mostly unavailable.

Table 9: **Removing Inland-favoring Policy: Total Land Supply (km^2)**

Regions (location, development)	No. of Cities	Land Supply (Data) 2003	2005	2010	Counterfactual $\widehat{2005}$	$\widehat{2010}$
National	225	19,498	22,268	28,336	22,268	28,336
(eastern, high)	8	2,000	2,190	2,938	2,582	4,377
(eastern, mid)	28	5,836	6,641	8,512	6,925	9,946
(eastern, low)	61	3,890	4,300	5,335	4,295	4,781
(non-eastern, mid)	9	795	873	1,266	836	864
(non-eastern low)	119	6,977	8,264	10,285	7,629	8,367

Notes: This table displays a summary of total urban land supply data by group (summations within group) in 2005 and 2010, as well as the counterfactual migration-based land supply in 2010 (unit: km^2). Regions are classified by the location of the city (east or non-east) and the level of development (GDP per capita) in 2005 as in the data. For the level of development, we equally divide all cities into three categories (high, mid, and low), based on their GDP per capita. Since there is no "high" development city in non-eastern region, we only have 5 groups in total. Each region consists of the same cities in both 2005 and 2010 for overtime comparison consistency.

Table 10: **Removing Inland-favoring Policy: Land Supply Per Thousand Workers (km^2/k)**

Regions (location, development)	No. of Cities	Land Supply (Data) 2005	2010	Counterfactual $\widehat{2005}$	$\widehat{2010}$
National	225	0.093	0.083	0.092	0.083
(eastern, high)	8	0.072	0.062	0.075	0.079
(eastern, mid)	28	0.082	0.084	0.085	0.094
(eastern, low)	61	0.083	0.076	0.083	0.070
(non-eastern, mid)	9	0.127	0.117	0.122	0.087
(non-eastern low)	119	0.121	0.092	0.113	0.079

Notes: This table displays a summary of total urban land supply data by group (weighted by urban population) in 2005 and 2010, as well as the counterfactual migration-based land supply in 2005 and 2010 (unit: km^2/k). Regions are classified by the location of the city (east or non-east) and the level of development (GDP per capita) in 2005 as in the data. For the level of development, we equally divide all cities into three categories (high, mid, and low), based on their GDP per capita. Since there is no "high" development city in non-eastern region, we only have 5 groups in total. Each region consists of the same cities in both 2005 and 2010 for overtime comparison consistency.

world. First, column 3-4 shows that more workers migrate to urban areas in developed cities when more land quotas are allocated to developed regions. Specifically, the urban low-skill (high-skill) population in eastern cities with high productivity can increase by 14.3% (4.2%) in 2005 and by 17.2% (11.2%) in 2010. On the contrary, under-developed cities will lose population. The urban low-skill (high-skill) population in non-eastern cities with low productivity declines by 1.6% (1.5%) in 2005 and by 5.6% (4.2%) in 2010. Second, column 5-6 displays the changes in the floor space prices. The national average residential floor and production floor space prices are reduced by 3.2% and 3.6%. As more land is supplied in developed cities, they experience a massive decrease of 20% in the floor space price. Third, column 7-8 shows the changes in the total output in different regions. We find an increase of about 2% in the total output in the urban area in China. The national-level output per capital can also increase by the level (column 9). Like previous outcomes, output in developed cities is increased a lot, at the cost of a relative decrease in regions with lower productivity. We find a 19.1% increase in the total output in eastern cities with high development, but 7.7% decrease in non-eastern cities with low productivity in 2010. However, according to column 9, the output per capita does not change as much as the total output within regions, which means that the loss in the output in under-developed areas is due to the loss in the population.

Table 11: **Removing Inland-favoring Policy: Population, Land Prices and Output**

Regions (location, development)	No. of Cities	Urban Population High	Urban Population Low	Floor Space Price Resid.	Floor Space Price Prod.	Total Output Urban	Total Output Rural	$\frac{\text{Urban Output}}{\text{Population}}$
Panel A: Percentage Changes in $\widehat{2005}$								
National	225	+0.1%	+1.5%	-3.2%	-3.6%	+2.2%	-0.9%	+2.2%
(eastern, high)	8	4.2%	14.3%	-22.7%	-22.7%	13.5%	0.6%	0.5%
(eastern, mid)	28	0.6%	1.2%	-6.1%	-6.1%	1.0%	0.4%	-0.1%
(eastern, low)	61	-0.7%	-0.7%	0.1%	0.1%	-0.8%	-1.0%	-0.1%
(non-eastern, mid)	9	-0.6%	-0.3%	6.3%	6.3%	-1.4%	0.0%	-1.0%
(non-eastern low)	119	-1.5%	-1.6%	-1.4%	-1.4%	-1.9%	-1.7%	-0.3%
Panel B: Percentage Changes in $\widehat{2010}$								
National	225	+0.1%	+1.4%	-7.8%	-5.8%	+2.4%	-1.1%	+2.4%
(eastern, high)	8	11.2%	17.2%	-23.5%	-23.5%	19.1%	5.6%	2.0%
(eastern, mid)	28	3.6%	5.3%	-22.9%	-22.9%	5.5%	1.8%	0.4%
(eastern, low)	61	-2.9%	-2.7%	7.9%	7.9%	-4.1%	-1.4%	-1.4%
(non-eastern, mid)	9	-7.3%	-8.3%	26.2%	26.2%	-13.2%	0.9%	-4.7%
(non-eastern low)	119	-4.2%	-5.6%	3.5%	3.5%	-7.7%	-3.6%	-2.1%

Notes: This table displays a summary of changes in urban population, floor space price, and total output by group (weighted by population) in 2005 and 2010 as well as its decomposition: Fund stands for fundamental, SP stands for skill premium, PSP stands for population scale premium, and LSP stands for land scale premium. Regions are classified by the location of the city (east or non-east) and the level of development (GDP per capita) in 2005 as in the data. For the level of development, we equally divide all cities into three categories (high, mid, and low), based on their GDP per capita. Since there is no "high" development city in non-eastern region, we only have 5 groups in total. Each region consists of the same cities in both 2005 and 2010 for overtime comparison consistency.

Measured TFP: Table 12 shows the effects of changing the land supply policy on national-level measured TFP. We can see that by keeping the pre-2003 land allocation rule and distributing more land to developed regions, we can increase the national-level TFP substantially by 6.2% in 2005 and by 7.3% in 2010. The decomposition also shows that most of the national TFP gains are driven by the increase in the fundamental term. We attract more workers to migrate to developed regions with a higher level of TFP, which raises the weighted national TFP. The TFP changes are not even across regions. In 2005, TFP in eastern cities with high productivity increases by 8.3%, and at the same time, there is almost no change in TFP in other cities. In 2010, although we find a larger increase of 16.2% in TFP in developed cities, there is also a significant decrease in under-developed cities due to the land losses. For instance, TFP in non-eastern cities with medium and low productivity decline by 10.4% and 4.9%, respectively. This result shows that although national TFP and output can be increased if we keep up with the pre-2003 land allocation policy, the regional productivity gap will also be increased.

Table 12: **Removing Inland-favoring Policy: Measured TFP**

Regions	No. of	2005					2010				
(location, development)	Cities	Total	Fund	SP	PSP	LSP	Total	Fund	SP	PSP	LSP
National	225	6.2%	5.1%	0.0%	0.0%	1.0%	7.3%	6.2%	-1.0%	1.0%	0.0%
(eastern, high)	8	8.3%	8.3%	-3.9%	1.0%	4.1%	16.2%	8.3%	-3.0%	2.0%	5.1%
(eastern, mid)	28	-2.0%	-2.0%	0.0%	0.0%	1.0%	2.0%	0.0%	0.0%	1.0%	1.0%
(eastern, low)	61	0.0%	0.0%	0.0%	0.0%	0.0%	-1.0%	0.0%	0.0%	-1.0%	-1.0%
(non-eastern, mid)	9	-1.0%	1.0%	0.0%	0.0%	-1.0%	-10.4%	-4.9%	0.0%	-1.0%	-4.9%
(non-eastern low)	119	0.0%	0.0%	0.0%	0.0%	0.0%	-4.9%	0.0%	-2.0%	0.0%	-3.0%

Notes: This table displays a summary of changes in measured TFP $ln(\widetilde{TFP}_{ju})$ by group (weighted by population) in 2005 and 2010 as well as its decomposition: Fund stands for fundamental, SP stands for skill premium, PSP stands for population scale premium, and LSP stands for land scale premium. Regions are classified by the location of the city (east or non-east) and the level of development (GDP per capita) in 2005 as in the data. For the level of development, we equally divide all cities into three categories (high, mid, and low), based on their GDP per capita. Since there is no "high" development city in non-eastern region, we only have 5 groups in total. Each region consists of the same cities in both 2005 and 2010 for overtime comparison consistency.

6.3 Effects on National Income Inequality

In the previous subsection, we find that regional inequality in productivity and output will widen if we remove the inland-favoring land supply policy. However, this is only true for regional inequality based on geographic measures of regions. Since land allocation policies motivate massive reallocation of workers, inequality measure based on workers' income better reflects the nature of inequality changes.

Table 13 shows the national-level income inequality changes in the counterfactual. If we can keep the pre-2003 land allocation rule, the overall inequality level of the country can be reduced by a lot. The national-level Theil Index is reduced by 34% in 2005 and by 32% in 2010. This is because by allocating more land to developed cities, we decrease residential and production floor space costs and increase labor demands in those places. This motivates more workers in under-developed cities to migrate to developed cities and earn a much higher income. Meanwhile, we do not see any changes in the skill premium, which means that most of the changes in inequality come from changes in migration.

Table 14 shows the changes of wage income for workers from different hometowns. We find that in the counterfactual world, the wages for workers from all places are larger than in the real world in 2005. Specifically, workers from non-eastern cities with low productivity gain the most, with a 2.4% increase in their wages. Similarly, in 2010, workers from cities with low productivity gain from keeping pre-2003 land policy, but workers from cities with mid and high productivity lose. Thus, the inland-favoring land policy in 2003 did not help workers from under-developed areas at all. It actually hurt them by reducing their wage incomes and enlarging wage inequality across the country.

In general, these results imply that even though it seems that the inland-favoring land supply policy achieved its original goal to shrink the regional productivity gap, it actually made the inequality problem worse and hurt workers from under-developed areas.

Table 13: **Removing Inland-favoring Policy: National Wage Income Inequality**

Income Measures	2005	$\widehat{2005}$	Changes	2010	$\widehat{2010}$	Changes
Theil Index	0.109	0.072	-34%	0.111	0.076	-32%
Skill Premium	1.73	1.72	-0.6%	1.60	1.60	0.0%

Notes: The calculation of the Theil Index is based on Fang and Huang (2020) and Novotnỳ (2007). The skill premium is defined as the ratio between wages of high-skill and low-skill workers.

6.4 Remarks on Counterfactual

Generally speaking, our counterfactual results show that the inland-favoring land supply policy resulted in a severe misallocation of construction land. It increased the price of residential and production floor space and discouraged workers from under-developed cities to migrate to developed cities. It then led to a massive loss in national-level output and TFP. It seems that the regional output and productivity gap was reduced, which was precisely the government's original goal. However, it actually exacerbated the income inequality problem rather than alleviating it. Many workers from under-developed cities lost their chances to migrate to developed cities to have higher wages. An important lesson we learn is that the ultimate goal of the policies

Table 14: **Removing Inland-favoring Policy: Regional Wage Income Inequality**

Regions (location, development)	No. of Cities	Hukou-based Average Wage Income					
		2005	$\widehat{2005}$	Changes	2010	$\widehat{2010}$	Changes
National	225	14.6	14.7	+0.6%	28.5	28.7	+0.7%
(eastern, high)	8	26.1	26.2	+0.4%	40.6	40.2	-1.2%
(eastern, mid)	28	20.8	20.8	+0.0%	36.3	36.3	+0.0%
(eastern, low)	61	12.9	13.0	+0.8%	26.3	26.7	+1.5%
(non-eastern, mid)	9	15.9	16.0	+0.6%	30.4	30.1	-1.0%
(non-eastern low)	119	12.6	12.9	+2.4%	26.5	26.9	+1.5%

Notes: This table displays a summary of Hukou-based average wage income by group (weighted by Hukou population) in 2005 and 2010, as well as the counterfactual migration-based land supply in 2005 and 2010 (unit: k RMB). Regions are classified by the location of the city (east or non-east) and the level of development (GDP per capita) in 2005 as in the data. For the level of development, we equally divide all cities into three categories (high, mid, and low), based on their GDP per capita. Since there is no "high" development city in non-eastern region, we only have 5 groups in total. Each region consists of the same cities in both 2005 and 2010 for overtime comparison consistency.

must lie on people, but not places. Reducing the regional output gap but simultaneously increasing national-level inequality cannot promote citizens' welfare at all. The inland-favoring policy was implemented to help people from under-developed regions (not regions themselves.), but it in fact, hurt them and made the whole country more unequal. The placed-based policy finally resulted in a paradox of helping the region but harming people in the region.

7 Conclusion

This paper studies how regulated land allocation policy creates spatial misallocation, focusing on a major policy change favoring under-developed non-eastern regions in China, also known as the Inland-favoring Policy, which is intended to balance the regional growth between the developed eastern regions and the under-developed non-eastern regions. Causal evidence shows that this policy change increased land prices and decreased firm-level TFP in the developed eastern region. A spatial equilibrium model shows that spatial misallocation was created because developed eastern regions have higher productivity and are more constrained in land supply. Counterfactuals of eliminating this inland-favoring policy can ease this spatial misallocation and improve national-level productivity and output.

Moreover, at the cost of sacrificing national-level productivity and output, the inland-favoring policy actually increased inequality. By eliminating this policy change, the national-level income inequality would also have been reduced thanks to more migration to developed cities.

This shows that even though the inland-favoring policy reduced the regional gap — inequality measured in geographic regions — it, in fact, caused TFP and output losses, worsens inequality measured in workers' income, and unfavorably hurt workers from under-developed regions by hindering their access to higher-paid developed cities.

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Appendix

A Additional Robustness Checks

In this section, we implement more robustness checks for our empirical analysis.

First, we drop Liaoning, Hebei, and their neighbor provinces. Since northeastern China also enjoyed favorable policies for regional development, Liaoning was not restricted by the land supply policy after 2003. Hebei, usually regarded as a coastal province, is actually more like a middle province in terms of its per capita GDP. Therefore, we drop the samples in Liaoning, Hebei, and their neighboring cities in the inland areas. Table A1, A2, and A3 show that the results are robust.

Second, we change the bandwidth for linear and quadratic fit.[14] We show two other bandwidth choices, 70 km and 90 km. Table A4 to A6 show the results on land prices, firm-level TFP measured by LP and OP method respectively. The results are very robust compared with the main regressions.

[14] We do not change bandwidth of the local linear regression since it already uses the optimal bandwidth.

Table A1: Robustness: Land Prices Regressions without Liaoning and Hebei

	Local Linear		Polynomial RD (Poly=1)		Polynomial RD (Poly=2)	
	Raw Border (1)	Thick Border (2)	Raw Border (3)	Thick Border (4)	Raw Border (5)	Thick Border (6)
East	-12.575***	-12.009***	-7.940***	-6.172***	-20.142***	-15.375***
	(1.985)	(1.659)	(1.617)	(1.319)	(4.720)	(2.618)
Post2003×east	12.931***	12.394***	8.340***	6.591***	20.446***	15.799***
	(1.988)	(1.685)	(1.602)	(1.297)	(4.743)	(2.631)
City Lagged Controls	Y	Y	Y	Y	Y	Y
Border FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Observations	91427	41206	123071	113349	123071	113349
Adjusted R-squared	0.047	0.068	0.043	0.041	0.044	0.042

Notes: The dependent variable is the land parcel-level price. The set of lagged city level control variables includes the log of GDP, the log of population, the log of city area, and the scale of the service sector. Sample in Local linear regression specification is restricted to be within an optimal bandwidth using a constant kernel. Sample in Polynomial RD is restricted to be within a bandwidth of 80 km around the raw boundary. *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.

Table A2: Robustness: TFP Regressions without Liaoning and Hebei (LP)

	Local Linear		Polynomial RD (Poly=1)		Polynomial RD (Poly=2)	
	Raw Border (1)	Thick Border (2)	Raw Border (3)	Thick Border (4)	Raw Border (5)	Thick Border (6)
East	0.281***	0.194**	0.317***	0.267***	0.281***	0.184**
	(0.100)	(0.093)	(0.059)	(0.050)	(0.083)	(0.077)
Post2003×East	-0.423***	-0.305***	-0.279***	-0.249***	-0.325***	-0.204**
	(0.073)	(0.088)	(0.064)	(0.056)	(0.078)	(0.085)
City Lagged Controls	Y	Y	Y	Y	Y	Y
Border FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Observations	59198	43604	235932	212859	235932	212859
Adjusted R-squared	0.089	0.104	0.086	0.089	0.087	0.089

Notes: The dependent variable is the firm-level TFP measured by LP method. The set of lagged city level control variables includes the log of GDP, the log of population, the log of city area, and the scale of the service sector. Sample in Local linear regression specification is restricted to be within an optimal bandwidth using a constant kernel. Sample in Polynomial RD is restricted to be within a bandwidth of 80 km around the raw boundary. *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.

Table A3: Robustness: TFP Regressions without Liaoning and Hebei (OP)

	Local Linear		Polynomial RD (Poly=1)		Polynomial RD (Poly=2)	
	Raw Border	Thick Border	Raw Border	Thick Border	Raw Border	Thick Border
	(1)	(2)	(3)	(4)	(5)	(6)
East	0.546***	0.368***	0.391***	0.300***	0.458***	0.242***
	(0.106)	(0.079)	(0.050)	(0.053)	(0.068)	(0.076)
Post2003×East	-0.448***	-0.220**	-0.272***	-0.196***	-0.340***	-0.132
	(0.059)	(0.099)	(0.057)	(0.060)	(0.062)	(0.090)
City Lagged Controls	Y	Y	Y	Y	Y	Y
Border FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Observations	38550	40744	235932	212859	235932	212859
Adjusted R-squared	0.150	0.148	0.136	0.137	0.136	0.137

Notes: The dependent variable is the firm-level TFP measured by OP method. The set of lagged city level control variables includes the log of GDP, the log of population, the log of city area, and the scale of the service sector. Sample in Local linear regression specification is restricted to be within an optimal bandwidth using a constant kernel. Sample in Polynomial RD is restricted to be within a bandwidth of 80 km around the raw boundary. *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.

Table A4: Robustness: Land Prices Regressions with Different Bandwidth Choices

	Polynomial RD (Poly=1)		Polynomial RD (Poly=2)	
	bandwidth=70km	bandwidth=90km	bandwidth=70km	bandwidth=90km
	(1)	(2)	(3)	(4)
East	-3.279**	-2.389**	-1.564	-5.720**
	(1.269)	(1.068)	(3.131)	(2.220)
Post2003×east	3.492***	2.780***	1.742	5.824***
	(1.261)	(1.055)	(3.118)	(2.203)
City Lagged Controls	Y	Y	Y	Y
Border FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Observations	147108	190990	147108	190990
Adjusted R-squared	0.057	0.049	0.058	0.051

Notes: The dependent variable is the land parcel-level price. The set of lagged city level control variables includes the log of GDP, the log of population, the log of city area, and the scale of the service sector. *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.

Table A5: Robustness: TFP Regressions with Different Bandwidth Choices (LP)

	Polynomial RD (Poly=1)		Polynomial RD (Poly=2)	
	bandwidth=70km	bandwidth=90km	bandwidth=70km	bandwidth=90km
	(1)	(2)	(3)	(4)
East	0.410***	0.434***	0.319***	0.389***
	(0.054)	(0.047)	(0.065)	(0.062)
Post2003×east	-0.436***	-0.412***	-0.485***	-0.469***
	(0.071)	(0.060)	(0.084)	(0.086)
City Lagged Controls	Y	Y	Y	Y
Border FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Observations	228271	340561	228271	340561
Adjusted R-squared	0.097	0.088	0.098	0.089

Notes: The dependent variable is the firm-level TFP measured by LP method. The set of lagged city level control variables includes the log of GDP, the log of population, the log of city area, and the scale of the service sector. *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.

Table A6: Robustness: TFP Regressions with Different Bandwidth Choices (OP)

	Polynomial RD (Poly=1)		Polynomial RD (Poly=2)	
	bandwidth=70km	bandwidth=90km	bandwidth=70km	bandwidth=90km
	(1)	(2)	(3)	(4)
East	0.412***	0.423***	0.449***	0.451***
	(0.049)	(0.041)	(0.054)	(0.053)
Post2003×east	-0.348***	-0.325***	-0.433***	-0.404***
	(0.059)	(0.049)	(0.060)	(0.065)
City Lagged Controls	Y	Y	Y	Y
Border FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Observations	228271	340561	228271	340561
Adjusted R-squared	0.157	0.148	0.157	0.148

Notes: The dependent variable is the firm-level TFP measured by OP method. The set of lagged city level control variables includes the log of GDP, the log of population, the log of city area, and the scale of the service sector. *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.

B Algorithm for Counterfactual Analysis

Given the exogenous variables and parameters, we need to calculate the response of endogenous variables resulting from some policy changes. As we have mentioned, we will select the equilibrium that is the closest to the one in the real world. Thus, the initial values of the variables will be set to be equal to the model result in 2005 and 2010. Since we have a within-city land market between residential and production usages, we adopt a double-loop variation of the method in Fang and Huang (2020).

We first specify the exogenous variables and the model equation system. The exogenous variables would be $\{H_i^s, \epsilon_j^s, \tau_{ij}^s, L_j, \phi_j, \eta_j\}$ where i index Hukou city, j index destination city, and s index skill. The equation system consists of three blocks: 1). Migration Block: worker income equations, and gravity equations; 2). Production Block: production equations, wage equations, and production floor space price equations; 3). Housing Block: construction equations and market clearing equations.

To calculate the counterfactuals after some policy changes, we start with the block which changes happens, and then iterate block by block to update the endogenous variables until all endogenous variables converge to certain small thresholds. We present the process of calculating a counterfactual which is direct increase land supply as an example below.

Suppose a land reallocation policy is $\hat{L_j} = \Delta_j \times L_j$ for every city j. We have a following process of updating variables $\{\hat{x_{jk}}\}^{OI}$ which indicates t's iteration of variable x. Let's start with the housing block just for initiating (there is no need to update $\{\hat{S_j}\}^*$ again):

Outer Loop: In the outer loop we update the floor space distribution between residential and production usages according to the inner loop equilibrium unit prices of residential and production floor space. The outer loop converges when the prices satisfies the equilibrium price equation between both markets.

Step 1: Initiating (make sure of non-zero floor space supply)

$$\{\hat{S_{ju}}\}^* = \phi_j \hat{L_j} \tag{38}$$

$$\{\hat{S_{ju}^R}\}^1 = S_{ju}^R \times (\{\hat{S_{ju}}\}^* / S_{ju}) \tag{39}$$

$$\{\hat{S_{ju}^M}\}^1 = S_{ju}^M \times (\{\hat{S_{ju}}\}^* / S_{ju}) \tag{40}$$

Step 2: **Inner Loop** (feedback prices to Outer Loop, x^{1*} means Inner Loop for x converges)

$$\{\hat{Q}_{ju}\}^{\mathbf{1}^*} = \frac{1-\beta}{\beta}\frac{\{w_{ju}^l H_{ju}^l + w_{ju}^h H_{ju}^h\}^{\mathbf{1}^*}}{\{\hat{S_{ju}^R}\}^1} \tag{41}$$

$$\{\hat{q}_{ju}\}^{\mathbf{1}^*} = (1-\alpha)\left(\frac{\alpha}{\{\hat{W}_{ju}\}^{\mathbf{1}^*}}\right)^{\frac{\alpha}{1-\alpha}} \tag{42}$$

Step 3: Compare floor space prices, generate excess demand for residential. The core idea is that if $\{\hat{Q}_{ju}\}^{\mathbf{1}^*} > \frac{\{\hat{q}_{ju}\}^{\mathbf{1}^*}}{\eta_j}$, residential floor space is smaller than equilibrium and production floor space is larger than equilibrium, so we need to redistribute more residential floor space to production floor space, until $\{\hat{Q}_{ju}\}^{\mathbf{1}^*} = \frac{\{\hat{q}_{ju}\}^{\mathbf{1}^*}}{\eta_j}$. We update partially with step size γ.

$$\{ED_j^R\}^1 = \gamma\left(\frac{\{\hat{Q}_{ju}\}^{\mathbf{1}^*} - \frac{\{\hat{q}_{ju}\}^{\mathbf{1}^*}}{\eta_j}}{\{\hat{Q}_{ju}\}^{\mathbf{1}^*} + \frac{\{\hat{q}_{ju}\}^{\mathbf{1}^*}}{\eta_j}}\right) \times \{\hat{S_{ju}^R}\}^1 \tag{43}$$

Step 4: Update floor space

$$\{\hat{S_{ju}^R}\}^2 = \{\hat{S_{ju}^R}\}^1 + \{ED_j^R\}^1 \tag{44}$$

$$\{\hat{S_{ju}^M}\}^2 = \{\hat{S_{ju}^M}\}^1 - \{ED_j^R\}^1 \tag{45}$$

Finally, we repeat Step 2 to Step 4 until market clearing condition holds: $\{\hat{Q}_{ju}\}^{**} = \frac{\{\hat{q}_{ju}\}^{**}}{\eta_j}$.

Inner Loop: In the Inner Loop we update the migration and production decisions given the residential and production floor space. This Inner Loop is almost identical to Fang and Huang (2020)'s method. Notation: we denote by x^{OI} where O denotes the step in the Outer Loop and I denotes the step in the Inner Loop. Here we demonstrate with $O = 1$.

Step 2-1: Update housing block

$$\{\hat{Q}_{ju}\}^{11} = \frac{1-\beta}{\beta}\frac{w_{ju}^l H_{ju}^l + w_{ju}^h H_{ju}^h}{\{\hat{S_{ju}^R}\}^1} \tag{46}$$

$$\{\hat{Q}_{jr}\}^{11} = \tau\{\hat{Q}_{ju}\}^{11} \tag{47}$$

$$\{S_{jr}^R\}^{11} = \frac{1-\beta}{\beta}\frac{w_{jr}H_{jr}}{\{\hat{Q}_{jr}\}^{11}} \tag{48}$$

Step 2-2: Update migration block

$$\{\hat{v^s_{in,jk}}\}^{11} = w^s_{jk} + \frac{\{\hat{Q}_{in}\}^{11}\{\hat{S^R_{in}}\}^{11}}{H^R_{in}} \quad \text{from eq.(6)} \tag{49}$$

$$\{\hat{\pi^s_{in,jk}}\}^{11} = \frac{(\tau^s_{in,jk}\{\hat{Q}_{jk}\}^{11^{1-\beta}})^{-\epsilon}(\{\hat{v^s_{in,jk}}\}^{11})^{\epsilon}}{\sum_{j'k'=11}^{JK}(\tau^s_{in,jk}\{\hat{Q}_{j'k'}\}^{11^{1-\beta}})^{-\epsilon}(\{\hat{v^s_{in,j'k'}}\}^{11})^{\epsilon}} \text{ from eq.(12)} \tag{50}$$

Then, combining $\{\hat{\pi^s_{in,jk}}\}^{11}$ with $\{H^s_{in}\}$, we are able to calculate $\{\hat{H^s_{jk}}\}^{11}$.

Step 2-3: Update production block

$$\{\hat{X}_{ju}\}^{11} = [(\{A^h_{ju}\}^{11}\{\hat{H^h_{ju}}\}^{11})^{\frac{\sigma-1}{\sigma}} + (\{A^l_{ju}\}^{11}\{\hat{H^l_{ju}}\}^{11})^{\frac{\sigma-1}{\sigma}}]^{\frac{\sigma}{\sigma-1}} \text{ from eq.(13)} \tag{51}$$

$$\{\hat{w^l_{ju}}\}^{11} = \alpha(\{\hat{X}_{ju}\}^{11})^{\alpha-1}(\{\hat{S^M_{ju}}\}^{1})^{1-\alpha}(\{A^l_{ju}\}^{11})^{\frac{\sigma-1}{\sigma}}(\{\hat{X}_{ju}\}^{11})^{\frac{1}{\sigma}}(\{\hat{H^l_{ju}}\}^{11})^{-\frac{1}{\sigma}} \text{ from eq.(14)} \tag{52}$$

$$\{\hat{w^h_{ju}}\}^{11} = \alpha(\{\hat{X}_{ju}\}^{11})^{\alpha-1}(\{\hat{S^M_{ju}}\}^{1})^{1-\alpha}(\{A^h_{ju}\}^{11})^{\frac{\sigma-1}{\sigma}}(\{\hat{X}_{ju}\}^{11})^{\frac{1}{\sigma}}(\{\hat{H^h_{ju}}\}^{11})^{-\frac{1}{\sigma}} \text{ from eq.(15)} \tag{53}$$

Step 2-4: Update prices

$$\{\hat{Q}_{ju}\}^{12} = \frac{1-\beta}{\beta}\frac{\{w^l_{ju}H^l_{ju} + w^h_{ju}H^h_{ju}\}^{11}}{\{\hat{S^R_{ju}}\}^{1}} \tag{54}$$

We repeat Step 2-1 to Step 2-4 until residential floor space prices $\{\hat{Q}_{ju}\}^{1t}$ converge to $\{\hat{Q}_{ju}\}^{1*}$. We then output $\{\hat{Q}_{ju}\}^{1*}$ and $\{\hat{q}_{ju}\}^{1*}$ for the use in the outer loop.

$$\{\hat{Q}_{ju}\}^{1*} = \frac{1-\beta}{\beta}\frac{\{w^l_{ju}H^l_{ju} + w^h_{ju}H^h_{ju}\}^{1*}}{\{\hat{S^R_{ju}}\}^{1}} \tag{55}$$

$$\{\hat{W}_{ju}\}^{11} = \frac{\{\hat{w^h_{ju}}\}^{11}\{\hat{H^h_{ju}}\}^{11} + \{\hat{w^l_{ju}}\}^{11}\{\hat{H^l_{ju}}\}^{11}}{\{\hat{X}_{ju}\}^{11}} \tag{56}$$

$$\{\hat{q}_{ju}\}^{1*} = (1-\alpha)\left(\frac{\alpha}{\{\hat{W}_{ju}\}^{1*}}\right)^{\frac{\alpha}{1-\alpha}} \tag{57}$$

C Counterfactual: Relaxing the Within-City Distortions

The second counterfactual land allocation policy we evaluate is to eliminate the within-city distortions between residential and production floor space usages. We eliminate the within-city distortions between residential floor space and production floor space prices by choosing the η_j all equal to 0.85 in both 2005 and 2010, which is relative price in the unconstrained regions as in Table 8.

Table C1: **Outcomes of Relaxing the Within-City Distortions**

Regions	No. of	Urban Population		Floor Space Price		Total Output		$\frac{\text{Urban Output}}{\text{Population}}$
(location, development)	Cities	High	Low	Resid.	Prod.	Urban	Rural	
Panel A: Percentage Changes in $\widehat{2005}$								
National	225	0.0%	0.0%	-9.1%	-9.1%	2.0%	0.0%	2.0%
(eastern, high)	8	-1.2%	-1.5%	-3.6%	-3.6%	0.0%	0.0%	0.2%
(eastern, mid)	28	0.0%	0.0%	2.7%	2.7%	3.8%	-0.8%	3.8%
(eastern, low)	61	0.9%	1.1%	-25.0%	-25.0%	1.1%	0.6%	0.1%
(non-eastern, mid)	9	-0.2%	-0.7%	-4.5%	-4.5%	0.0%	0.0%	0.6%
(non-eastern low)	119	0.0%	-0.2%	-8.9%	-8.9%	0.9%	0.0%	1.1%
Panel B: Percentage Changes in $\widehat{2010}$								
National	225	0.0%	-0.4%	-1.9%	-1.9%	0.8%	0.3%	0.8%
(eastern, high)	8	-0.4%	-0.7%	10.7%	10.7%	3.3%	-3.5%	3.9%
(eastern, mid)	28	-0.5%	-0.5%	0.6%	0.6%	0.7%	-0.8%	1.2%
(eastern, low)	61	0.0%	0.0%	-7.3%	-7.3%	-0.9%	0.6%	-0.9%
(non-eastern, mid)	9	-0.3%	-0.2%	4.8%	4.8%	1.2%	-1.9%	1.4%
(non-eastern low)	119	0.0%	-0.3%	-5.4%	-5.4%	-0.6%	1.0%	-0.3%

Notes: This table displays a summary of changes in urban population, floor space price, and total output by group (weighted by population) in 2005 and 2010 as well as its decomposition: Fund stands for fundamental, SP stands for skill premium, PSP stands for population scale premium, and LSP stands for land scale premium. Regions are classified by the location of the city (east or non-east) and the level of development (GDP per capita) in 2005 as in the data. For the level of development, we equally divide all cities into three categories (high, mid, and low), based on their GDP per capita. Since there is no "high" development city in non-eastern region, we only have 5 groups in total. Each region consists of the same cities in both 2005 and 2010 for overtime comparison consistency.

Table C2: **Measured TFP of Relaxing the Within-City Distortions**

Regions	No. of	2005					2010				
(location, development)	Cities	Total	Fund	SP	PSP	LSP	Total	Fund	SP	PSP	LSP
National	225	1.0%	0.0%	0.0%	0.0%	2.0%	0.2%	0.0%	0.0%	0.0%	0.3%
(eastern, high)	8	1.0%	0.0%	0.0%	0.0%	1.0%	5.1%	0.0%	0.0%	0.0%	4.1%
(eastern, mid)	28	3.0%	0.0%	0.0%	0.0%	3.0%	1.0%	0.0%	0.0%	0.0%	0.3%
(eastern, low)	61	0.2%	0.0%	0.0%	0.0%	1.0%	0.0%	0.0%	0.0%	0.0%	-1.0%
(non-eastern, mid)	9	0.0%	0.0%	0.0%	0.0%	1.0%	2.0%	0.0%	0.0%	0.0%	1.0%
(non-eastern low)	119	1.0%	0.0%	0.0%	0.0%	1.0%	0.0%	0.0%	-2.0%	0.0%	0.0%

Notes: This table displays a summary of changes in measured TFP $ln(\widetilde{TFP}_{ju})$ by group (weighted by population) in 2005 and 2010 as well as its decomposition: Fund stands for fundamental, SP stands for skill premium, PSP stands for population scale premium, and LSP stands for land scale premium. Regions are classified by the location of the city (east or non-east) and the level of development (GDP per capita) in 2005 as in the data. For the level of development, we equally divide all cities into three categories (high, mid, and low), based on their GDP per capita. Since there is no "high" development city in non-eastern region, we only have 5 groups in total. Each region consists of the same cities in both 2005 and 2010 for overtime comparison consistency.