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. Combining microdata and a spatial equilibrium model, we investigate a major policy change of distributing more land to underdeveloped inland regions in China. First, by a method combining RD and DID, we show causal evidence that this inland-favoring policy increased land prices and decreased firm-level TFP in more developed eastern regions relative to inland regions. Second, we build a spatial equilibrium model featuring worker mobility and floor space constraints on housing and production. The inland-favoring policy is neither fair nor efficient. Counterfactuals reveal that national TFP and urban output would have been 7.3% and 2.4% higher in 2010 if the policy had not been implemented. Moreover, wage and income of workers from underdeveloped regions would have increased by 1% to 2%. The inland-favoring policy seems to reduce regional output gaps, however, it actually hurts workers from underdeveloped regions by hindering their migration to developed regions with high wages while causing aggregate TFP and output losses. We then show that instead of the inland-favoring policy, a direct regional transfer can increase the income of people from underdeveloped regions without causing substantial efficiency loss.

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 underperforming regions to promote balanced development. However, such balanced development may come at the cost of generating spatial misallocation. Moreover, the balance across regions does not necessarily mean equality among people. For example, the place-beased policy can deter people from migrating to places with higher wages. Such detrimental place-based policies may result in the 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 policy on economic development using China's inland-favoring land supply policy in 2003. Unlike western countries, the state owns urban land in China. Construction companies need to buy using rights from the state before they can build anything there. 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.[1] Similar to other place-based policies, the inland-favoring land supply policy aims to mitigate the unbalanced development across regions due to the rapid economic growth in the east near the coastline (Lin, 2011; Fleisher, Li, and Zhao, 2010).[2] It reversed an incumbent demand-driven land distributing rule, which favored fast-growing eastern cities before 2003, to a development-encouraging distributing rule, which favored underdeveloped non-eastern cities after 2003.

We analyze the consequences of this policy change in three steps. First, we combine Regression Discontinuity and Difference-in-Differences approaches (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. We find that 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 increased, the income of workers from underdeveloped cities would also have increased. These results show that the inland-favoring policy creates spatial misallocation, which not only lowers

[1] Readers can think of the land market in China as a monopoly one controlled by the Chinese government.

[2] China is currently the largest developing economy and has 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 eastern cities the keys to the global market. Consequently, eastern areas achieved massive growth relative to the rest of the country, which has become a major concern of the Chinese government.

overall productivity and output, but also harms people from poor areas.

The mechanism is as follows. Compared with the inland regions, the eastern regions are on average more productive and more constrained in land supply. After the implementation of the inland-favoring policy, the eastern regions become even more constrained in land and land prices increases, which leads to increases in floor space costs. This not only increases housing costs, but also increases the costs of production space, which results in reduced labor demand. Both effects then deter the migration of workers from inland regions to the eastern regions with higher productivity. The misallocation of land and labor leads to reductions in national output and productivity. The income of workers from underdeveloped regions is reduced since many migrants are locked in their hometowns and lose their chance to migrate to more productive eastern cities with higher wages. Thus, the resulting geographic output convergence is just an illusion that hurts workers.

In the first part of this study, we empirically investigate the effect of the inland-favoring land supply policy adopted 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. 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 other regions, in terms of both observed and unobserved characteristics. To solve this endogeneity issue, we employ a method combining Border Regression Discontinuity Design (Black, 1999) and Difference-in-Differences approaches (RD-DID). The basic idea is that land parcels and firms within a minimal bandwidth along the border are very similar, no matter whether they are located on the eastern side or inland side. Thus, their prices and TFP should have a similar time trend. Then we can implement a DID strategy on these samples to identify the effect of the inland-favoring land supply policy. We find that the inland-favoring policy in 2003 led to 3.3-9.4% increase in land prices in the developed eastern region compared with the inland region. Furthermore, this policy also reduced firm-level TFP in the eastern region by 0.24-0.49%, compared with the inland region. Thus, the empirical analysis shows that the inland-favoring land supply policy shrank the productivity gap between the eastern and the inland regions. However, it came at the cost of slower growth in the eastern region and possibly the overall Chinese economy.

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. City here means prefecture in China, which includes both the urban region and its surrounding rural region in a given administrative area. 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 a 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 policy, and construction firms can convert land to floor space at a fixed ratio that varies across 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 clear 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 to 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 constrained, and the per capita land supply is much smaller than that in underdeveloped cities.

Finally, using this model, we implement two counterfactual simulations. In the first one, we examine what would happen if the pre-2003 land supply policy was 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 inland-favoring policy. We find that this increases land supply in eastern cities with higher productivity and decreases their floor space prices. This attracts more migrants to these cities and results in a 2.2% (2.4%) increase in 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, national TFP would increase by 6.2% in 2005 and by 7.3% in 2010. However, the removal of the policy would reduce output and productivity in underdeveloped cities and cause a larger regional output gap, suggesting that the inland-favoring policy achieves regional convergence by balancing regional development. However, this is just an illusion. We find that removing the inland-favoring policy can lead to increases in wages and total income for workers from almost all places. Specifically, there is a 1-2% increase in the average wage and total income of workers from underdeveloped areas. In the second counterfactual, we propose a direct regional transfer to replace the inland-favoring land policy. We show that the direct transfer can increase the income of people from underdeveloped regions and creates less misallocation and distortion.

In general, the inland-favoring land supply policy resulted in severe land misallocation. It not only caused overall output and TFP losses, but also hurt workers in underdeveloped regions whom it intended to help. The convergence between regions is just an illusion since almost all workers across China were hurt, including those from poor areas. These analyses teach us an important lesson that even if place-based policies sometimes can help specific areas, 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), discretionary grants (Crozet, Mayer, and Mucchielli, 2004; Devereux, Griffith, and Simpson, 2007), 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 where the region may benefit but residents from the region are harmed.

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; Fu, Xu, and Zhang, 2021). 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 implications for inequality in China. They find that as migration explodes, constrained land supply in developed cities leads to dramatic increases in 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 have investigated the Hukou restriction and regional trade barriers (Tombe and Zhu, 2019; Hao et al., 2019; Pi and Chen, 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. Construction companies need to buy the using rights from the government if they want to build houses or other constructions. To ensure that there is enough agricultural land for the 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 coastal areas will be strictly controlled, and land-use quotas in 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 focus on balancing economic development by allocating more land quotas to underdeveloped inland provinces (Lu and Xiang, 2016; Han and Lu, 2017; Liang, Lu, and Zhang, 2016; Fu, Xu, and Zhang, 2021). 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]

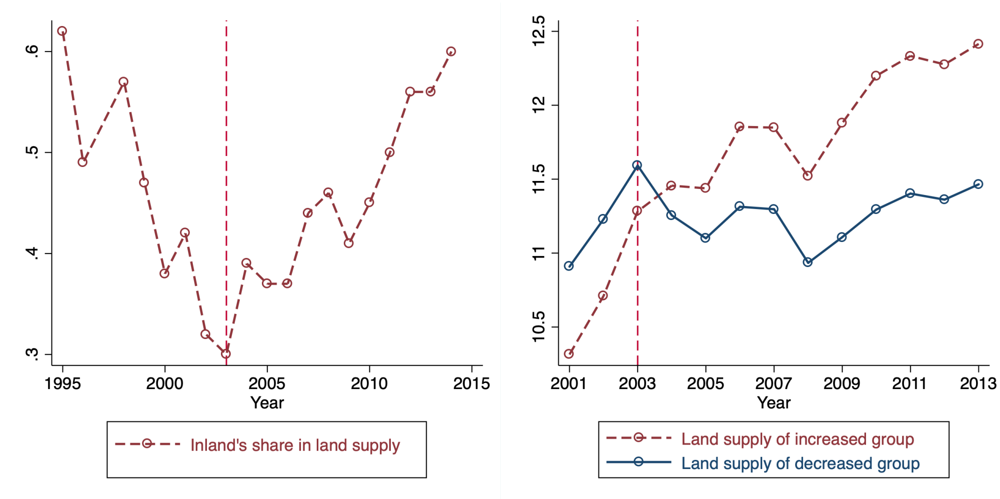
Figure 1 panel (a) shows that the inland provinces' share of the total land supply increased from less than 30% in 2003 to 60% in 2015. The turning point in 2003 is clear. Another policy change related to land supply is that, during 2003–2004, about 70% of existing development zones were closed. The planned land supply for these 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 inland areas to support 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 new land supply shares increased after 2003, the other with the cities whose new land supply shares shrank after 2003. Land supply in the first group was lower before 2003, but it jumped and surpassed the second group after 2003, with the gap growing over time. Han and Lu

[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 of Land Supply (b) Divergence between City Groups



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

(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. These were usually developed eastern cities.

2.2 Data

2.2.1 Data for the Empirical Analysis

The main dataset we use in the empirical exercise is land transaction data from 1998 to 2014, collected from the China Land Market Website (http://www.landchina.com/). It includes unique land IDs, 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 local land administration departments to publish information on the transfer of state-owned land-use rights. Prices are denominated in 10000 Yuan per hectare. Panel A in Table 1 shows the descriptive statistics of the land market 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 than 90% of all industrial production. Since one of our major concerns is TFP, and there is a problem of missing data after 2007, we only use the samples from 1998 to 2007. The database contains rich enterprise-level information, such as firm name, four-digit industry category, starting year of business, employee number, total salary, and total fixed assets.[4] Panel B in Table 1 shows the descriptive statistics of the data. Our TFP calculation is based on OP (Olley and Pakes, 1992) estimation methods.[5]

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 eastern land and negative for inland land. Firm distance is the distance from the firm's location to the east–inland provincial boundary, which is positive for eastern land and negative for western land. All chosen samples are within 200 km of the boundary.

2.2.2 Data for the 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, the Chinese government carries out a thorough investigation of all the households in the country, which is called the Census. All families must take a short survey, which requires them to provide basic demographic information such as name, age, gender, education, and living address. Among all families, 10% of them must take a long survey. The long survey questionnaire includes additional information

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

[5]We also calculate the TFP using the LP (Levinsohn and Petrin, 2003) method. The results are similar, which are available in Appendix A.1.

such as job informations and birth history. Between each decennial Census, there is a mini-Census. For each mini-Census, the National Bureau of Statistics randomly chooses 10% of the population to complete a survey which is similar to the long survey in the decennial Census. For simplicity, we call both the decennial Census and the mini-Census as Census data. In this study, we use Census data from 2005 and 2010. This gives 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 data on its city-level information and publishes it annually. 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 have 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 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.

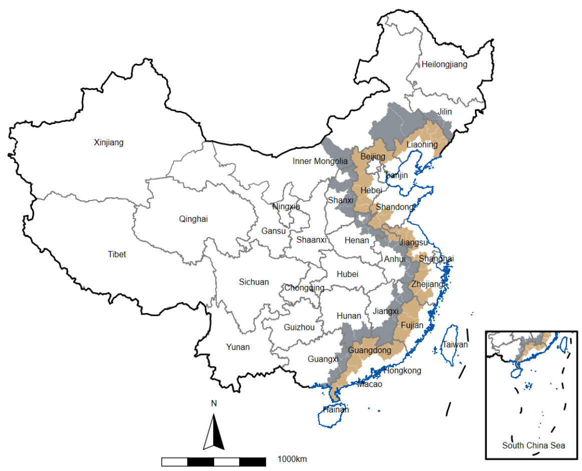
3 Empirical Evidence

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

3.1 RD-DID Specification

The empirical strategy we use is a combination of a Border Regression Discontinuity Design (Black, 1999) and a Difference-in-Differences approach (RD-DID). The basic idea is to first compare land parcel prices on the eastern and inland sides of the border. Then we compare this border price difference over time, particularly before and after the year when the central government implemented the inland-favoring land supply policy. Figure 2 shows the location of the boundary (at prefecture level) between the eastern and inland regions in China. We use the definition of eastern and non-eastern regions published by the National Bureau of Statistics of China.

Figure 2: Boundary between Eastern and Non-Eastern Region in China



Notes: Data sources are the National Bureau of Statistics of China.

For land parcel i at border segment b in city c, year t, we have the following regression:

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

where 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, and $Post2003$ is a dummy which equals 1 if t is after 2003 (including 2003 itself)[6]. 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 value added 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.[7] γ_t is the year fixed effect.

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

[7] We also try specifications where we also control for city and province 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

This is a regression combining RD and DID methods. First, consider the first three terms (except the intercept), that is, $\beta_1 East_{ibc} + \beta_2 f(Dist_{ibc}) + \beta_3 East_{ibc} \times f(Dist_{ibc})$. This comprises a border regression discontinuity design regression with the running variable being the distance to the border. Using the observations within a small bandwidth, we 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 the local linear fit is based on Imbens and Kalyanaraman (2012). The bandwidth we use for the linear and quadratic fit is 80 km.[8]

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 change in eastern region effects before and after the 2003 inland-favoring land allocation policy. Thus, this is a difference-in-differences estimation. The first difference is between the eastern and the inland regions (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-differences. We mainly investigate two outcome variables, land prices at land parcel-level and TFP at firm-level.[9]

3.2 Regression Assumptions Validation

One of the most important assumptions of any estimation involving the DID method is the parallel trend assumption. Figure 3 shows the time trends of the two main outcome variables, land prices and firm-level TFP calculated using the OP method.[10] 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 represents the year 2002, just before the implementation of the inland-favoring land policy. There is no evidence of different time trends before the policy, although we have only limited data points for land prices.[11]

Furthermore, we implement a traditional event study regression to investigate the evolution

context is because city or province fixed effects will absorb all variations at the city or province level, which leads β_1 to be unidentified.

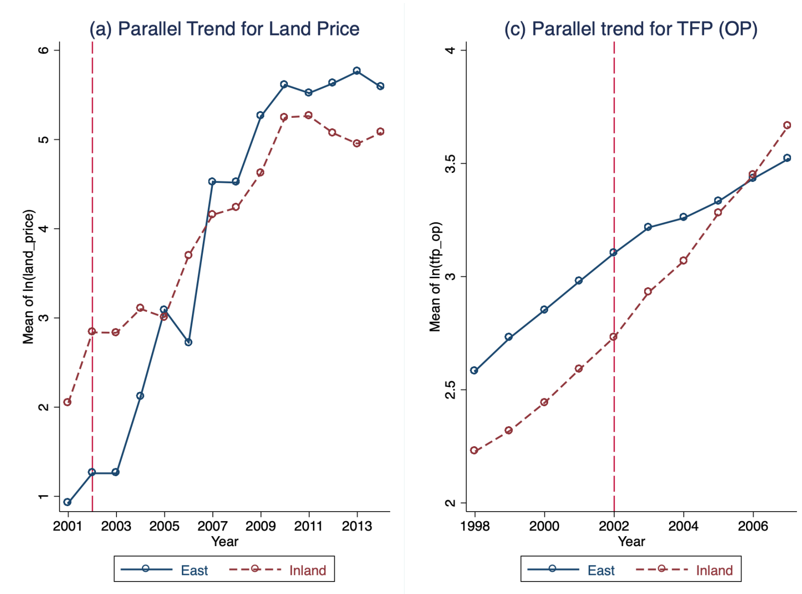
[8]We also try some other bandwidths, the results are similar. Please refer to Appendix A.1 for details.

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

[10]The parallel trend test on TFP calculated using the LP method is available in Appendix A.1.

[11]We do not have enough data for land parcels at the border before 2001. Thus, for the parallel trend test of land price, we only show results after 2001.

Figure 3: Parallel Trend of Outcome Variables



Notes: This figure shows the time trends of two main outcome variables, land prices, 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. 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.

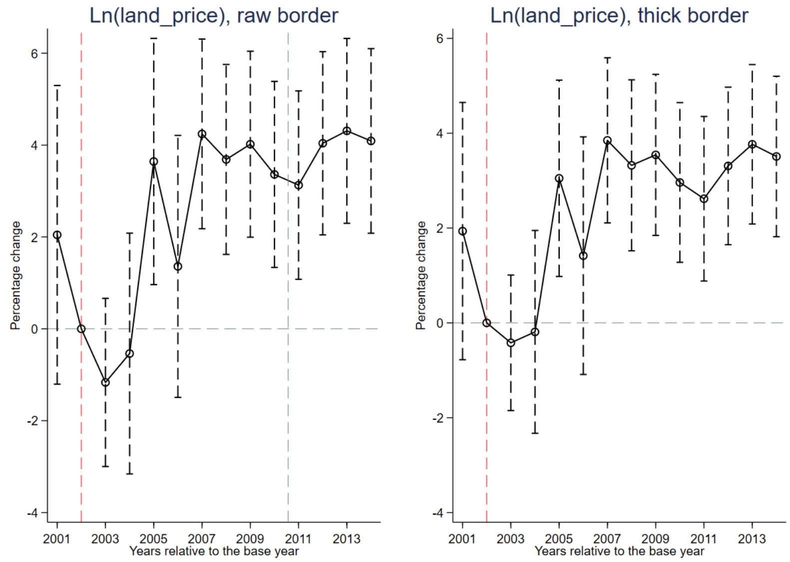
of the eastern region effect across time. We take the year of 2002 as the baseline and then have the following regression:

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

We plot the evolution of the coefficient δ_{1s} across time s in Figures 4, and 5. These figures show the changes of the eastern region effect across time, with 95% confidence intervals. We choose a linear smoothing function and use either the raw border or the thick border recommended in (Michalopoulos and Papaioannou, 2014) in the regression.[12] We find that all the coefficients are

[12]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 geographies on land prices. We also try regressions using local linear and quadratic smoothing functions. The test results are not changed. They are available upon request.

Figure 4: Event Study - Land Price



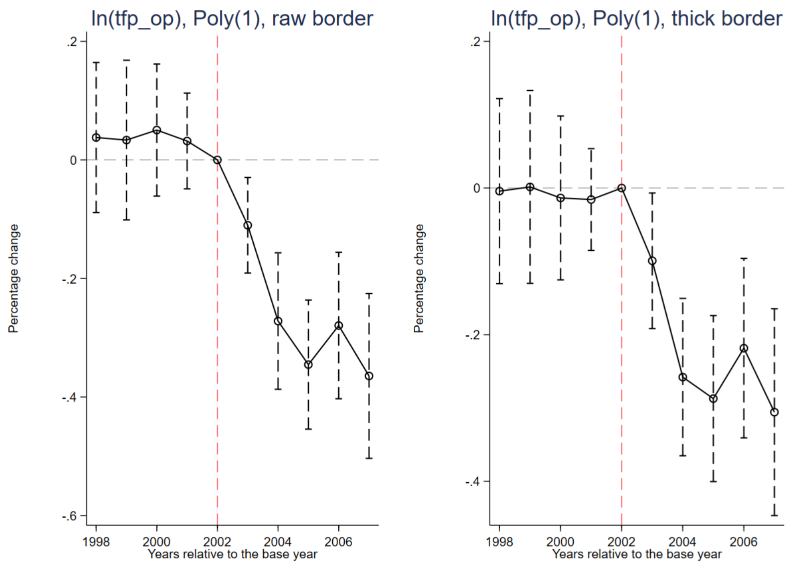
Notes: The dependent variable is the land parcel-level price. We only show the results for the linear fitting function since we do not have enough observations before 2003 for quadratic fitting function. As we add in high order polynomials, the behavior of the fitting becomes weired, which indicates a typical overfitting and boundary problem. The bandwidth is 80km. The confidence interval is 95%.

very close to zero before 2002. They become statistically and economically significant from zero only after the policy was implemented. The results from this event study confirm that there is no pre-trend in our data. These figures also give us a preview 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 land prices in the eastern region. Meanwhile, the policy also decreased the relative firm productivity in the eastern region. A more detailed discussion follows in the next section. We also implement more validation tests and the results are available in Appendix A.1 and A.2.

3.3 RD-DID Results

Table 2 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 a local linear smoothing function. The third and fourth columns illustrate the results when we use a first order (linear) polynomial smoothing function. The last two columns illustrate the results when we use a second order (quadratic) polynomial smoothing function. In general, we can see that before the inland-favoring

Figure 5: Event Study - TFP (OP)



Notes: The dependent variable is firm-level TFP calculated by the OP method. The bandwidth is 80 km from the border of eastern and non-eastern classification. The confidence interval is 95%.

land supply policy was imposed, the eastern region had 3.0-9.2% lower land prices. However, the policy eliminated the price gap. The reduction in the construction land quota after 2003 led to approximately a 3.3-9.4% increase in land prices in the developed eastern region.

Table 3 shows the regression results when we use the log of firm-level TFP as the outcome variable. We find that before the policy, eastern firms generally had 0.34-0.51% higher TFP than non-eastern firms. However, the reduction in the construction land supply after 2003 reduced the relative TFP of eastern firms by 0.24-0.49%. In addition to TFP, we also run the same regressions for firm-level output, average wages, and return on assets. They all show the same pattern: that the inland-favoring land policy decreased the relative output, wages and return on assets in the eastern region. The detailed results are available upon request.

3.4 Remarks on Empirical Results

In the empirical part, we have two main findings. First, the inland-favoring land supply policy reduced land supply and increased land prices in the developed eastern region relative to the non-eastern inland region. Second, the inland-favoring land supply policy also decreased firm relative productivity in the eastern region. In Appendix A.1, we implement more robustness checks to

Table 2: RD-DID Results on Land Prices

	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	-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 value added of the service sector. The sample in the Local Linear regression specification is restricted to be within an optimal bandwidth using a constant kernel. The sample for the Polynomial RD cases 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 3: 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 firm-level TFP measured by the 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. The sample in the Local Linear regression specification is restricted to be within an optimal bandwidth using a constant kernel. The sample in the Polynomial RD cases is restricted to be within a bandwidth of 80 km around the raw boundary. *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.

validate our empirical findings. The results show that the conclusions are maintained in different specifications.

We claim that although government achieved the goal of shrinking the productivity gap between eastern and inland regions, it came at a substantial cost. In the eastern region, when land prices increased, residential costs increased for workers and land costs also increased for firms. This encourages firms and workers to relocate to other places with lower costs, leaving the developed region with higher productivity. This can lead to a loss in terms of national TFP and output. Inequality may also increase rather than decrease since the policy prevents the migration of many workers from underdeveloped areas to developed cities with higher wages. Thus, the policy may hurt the people it intended to help. We explain this mechanism in more detail in the next few sections.

So far, we have discussed the local effect of the inland-favoring policy on land misallocation. However, these results are local average treatment effects at the border. There are still more questions to ask. What is the national effect? What is the effect on labor misallocation? How are the wage and income of workers from different regions affected? To answer, we turn to a model.

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 urban land supply L_i^u of the urban region. In urban areas, floor space can be used for both production and housing, 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 simplified such that the rent is proportional to the average rent in urban areas in the same city.[13]

Workers decide whether or not to move after observing idiosyncratic utility shocks between each possible pair of destinations 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

[13]This model setting reflects the special land distribution system of rural China. All land in rural China is 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.

terms of their urban final goods productivity (A_i^u), rural final goods productivity (A_i^r), and supply of floor space in their urban region (S_i^u).

In the model of our main context, we do not consider the agglomeration effect due to the difficulty in estimating the parameters using Chinese data. In Appendix E, we introduce the agglomeration effect that city-level productivity is positively related to the population. Then we calibrate the agglomeration intensity using results from other countries in previous literature. All model results are not changed qualitatively.

4.1 Worker Preferences

The utility of worker o with skill s, originating 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 between urban residence and rural residence in the utility function, but allow rural workers to construct their own residential floor space by paying construction costs. For each worker o originating from region i sector n, migrating to region j sector k, the idiosyncratic component of utility ($z^o_{in,jk}$) is drawn from an 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 costs 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 cost differences between individuals with different skills which may include skill-biased migration policies or differences in their preferences for specific types of amenities such as education for children, entertainments, or 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 her or his utility, taking as given residential amenities, goods prices, factor prices, and the 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 who migrates 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 and Q_{jk} is the rent of the residential floor space in sector k in city j.

Floor space in city i sector n is not tradable and is owned in common by Hukou-registered workers originating from city i sector n. 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 which depends on skill s in city j sector k and equally-divided residential floor space rent income among all Hukou registrants in city 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 Hukou registrants including those who migrated to work elsewhere.[14]

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

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

[14] This assumption is different to Tombe and Zhu (2019) which makes a stronger assumption such that migrant workers have no claim to any fixed factor income from land of either their current working city or their Hukou city. In their model, whenever a worker migrate, she losses all the fixed factor income from her previously owned local property in her Hukou city. Our mechanism in this paper is even stronger with their assumption. However, we think the current assumption is closer to the institutional features of China.

4.2 Distribution of Migration Flows

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

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

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

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

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

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 following a Cobb-Douglas form, using some efficient labor combination X_j, and production floor space S^M_j:

$$Y_{ju} = (X_{ju})^{\alpha}(S^M_{ju})^{1-\alpha},\ \text{where } X_{ju} = [(A^h_{ju}H^h_{ju})^{\frac{\sigma-1}{\sigma}} + (A^l_{ju}H^l_{ju})^{\frac{\sigma-1}{\sigma}}]^{\frac{\sigma}{\sigma-1}} \tag{13}$$

where X_{ju} is a CES combination of high skill labor H^h_{ju} and low skill labor H^l_{ju} multiplied by their corresponding city-level efficiencies A^h_{ju} and A^l_{ju} respectively. In rural regions, 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 equilibrium, A_{jr} equals the wage return of agricultural sector w_{jr} in city j rural sector r.[15]

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 ($\{A^h_{ju}, A^l_{ju}\}$), the distribution of idiosyncratic utility, factor prices, and decisions of other firms and workers. From the first-order conditions, we obtain:

$$w^l_{ju} = \alpha X^{\alpha-1}_{ju} S^{M\,1-\alpha}_{ju} A^{l\;\frac{\sigma-1}{\sigma}}_{ju} X^{\frac{1}{\sigma}}_{ju} H^{l\;-\frac{1}{\sigma}}_{ju} \tag{14}$$

$$w^h_{ju} = \alpha X^{\alpha-1}_{ju} S^{M\,1-\alpha}_{ju} A^{h\;\frac{\sigma-1}{\sigma}}_{ju} X^{\frac{1}{\sigma}}_{ju} H^{h\;-\frac{1}{\sigma}}_{ju} \tag{15}$$

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

The zero profit property from the constant return to scale production function could determine the equilibrium production floor price q_j by

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

where $W_{ju}X_{ju} = w^l_{ju}H^l_{ju} + w^h_{ju}H^h_{ju}$. This together with profit maximization (16) yields the following expression for the equilibrium production floor price:

$$q_{ju} = (1-\alpha)\left(\frac{\alpha}{W_{ju}}\right)^{\frac{\alpha}{1-\alpha}} \tag{17}$$

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 land use regulations between production and housing:

$$q_{ju} = \eta_j Q_{ju} \tag{18}$$

[15] We make a simplification such that $w^h_{jr} = w^l_{jr} = w_{jr}$.

where η_j captures the land use regulations that restrict the price of production land relative to the price of residential land. 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 for 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:

$$S^M_{ju} = \left(\frac{(1-\alpha)}{q_{ju}}\right)^{\frac{1}{\alpha}} X_{ju} = \theta_j S_{ju} \tag{19}$$

Residential land market clearing implies that the demand for 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:

$$S^R_{ju} = E[s_{ju}]H_{ju} = (1-\beta)\frac{E[v_{ju}]H_j}{Q_{ju}} = (1-\theta_j)S_{ju} \tag{20}$$

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:

$$S_{ju} = \phi_j L_j \tag{21}$$

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 areas is simpler as there is no production land. We assume that rural housing costs are a fixed fraction of the urban cost:

$$Q_{jr} = \tau Q_{ju} \tag{22}$$

The price Q_{jr} is the cost of building a unit of floor space on rural land. Given the cost, rural residents choose the optimal amount of 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 the firm 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 migration choices pins down the equilibrium labor supply in each city* H^s_{jk} *and the migration flow between each city pair* $\pi^s_{in,jk}$.
>
> *(ii).**[Firm Optimization]** Taking the exogenous economic conditions* $\{A^s_{jk}\}$ *and the aggregate prices* $\{q_{ju}, w^s_{jk}\}$ *as given, firms' optimal production choices pins down the equilibrium labor demand* H^s_j *and 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* $\{Q_{ju}, q_{ju}, w^s_{jk}\}$, *equilibrium floor space* S_{ju}, *and 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 to match data moments. We first use some national average moments from various datasets to pin down share parameters in the preferences of workers (β), final good production (α), and floor space regulation (η). We then use the estimated elasticities from Fang and Huang (2020) for the city pair migration elasticity (ϵ). Table 4 gives a short summary table of our calibrated parameters.

We match $(1-\beta)$ to the share of residential floor space cost in consumer expenditure, $(1-\alpha)$ to the share of production floor space costs in firm costs, and $(\eta - 1)$ to the ratio of production

Table 4: **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

Notes: This table displays a summary of parameters. We match $(1-\beta)$ to the share of residential floor space cost in consumer expenditure, $(1-\alpha)$ to the share of production floor space costs in firm costs, and $(\eta-1)$ to the ratio of production land use costs over residential land. Summary statistics of η_j are in Table 6. The national means are 0.99 in 2005 and 0.96 in 2010. The elasticity of substitution between H/L-skills (σ) as in Katz and Murphy (1992) and the city pair migration elasticity (ϵ) is calibrated as in Fang and Huang (2020). 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 in both Census 2005 and Census 2010.

land use costs over residential land. First, to match $(1-\beta)$, we use the 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 measurement approach in 2012. We believe the new measurement standard is more realistic, which gives us an average share of roughly 23% from 2013 to 2017.[16] 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 the World Bank in 2005. Firms report tax payments based on land usage through which we can infer the costs of production land. The mean across all firms and cities is 12% 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 to residential land costs. Different city governments may have different incentives to promote residential or production construction through 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 we used in our empirical analysis. 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 as in Katz and Mur-

[16] 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 imputed rent costs of self-owned houses and apartments. From 2013, the imputed rent costs of self-owned houses and apartments were added to housing costs which resulted in a range from 22.7% in 2017 to 23.3% in 2013. Within each of these measurement regimes, we find that the average expenditure share is very stable across time.

phy (1992), which has been widely used in previous literature. The city pair migration elasticity (ϵ) is calibrated to be 1.9. Tombe and Zhu (2019) estimates this elasticity at the province-sector pair level and end up with a value of 1.5. Fang and Huang (2020) show that the city pair migration elasticity is around 1.9. We choose the latter value since it is estimated in an almost identical model context to this study. Finally, the relative cost of rural housing (τ) is calculated using the relative rent paid by observed rural sector workers over rent paid by observed urban sector workers in each city in both Census 2005 and Census 2010. This gives us a value of 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 can 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 can infer productivity from the data on employment and wages. First, we solve for productivity A^h_j as a function of A^l_j using first order conditions.

$$A^h_{ju} = A^l_{ju}\left(\frac{H^h_{ju}}{H^l_{ju}}\right)^{\frac{1}{\sigma-1}}\left(\frac{w^h_{ju}}{w^l_{ju}}\right)^{\frac{\sigma}{\sigma-1}} \tag{23}$$

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

$$X_{ju} = A^l_{ju}H^l_{ju}\left[\frac{w^h_{ju}H^h_{ju} + w^l_{ju}H^l_{ju}}{w^l_{ju}H^l_{ju}}\right]^{\frac{\sigma}{\sigma-1}} \equiv A^l_{ju}H^l_{ju}(\Xi^l_{ju})^{-\frac{\sigma}{\sigma-1}} \tag{24}$$

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. We also assume that agricultural productivity equals agricultural wages.

$$A^s_{jr} = w_{jr}, \quad \textit{for both } s = \{h, l\} \tag{25}$$

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

$$W_{ju} = \frac{w^h_{ju}H^h_{ju} + w^l_{ju}Hu^l_{ju}}{X_{ju}} = \frac{w^l_{ju}}{A^l_{ju}}(\Xi^l_{ju})^{\frac{1}{\sigma-1}} \tag{26}$$

Plugging W_j into the price function of q_j, we solve

$$A^l_{ju} = \frac{q_{ju}^{\frac{1-\alpha}{\alpha}} w^l_{ju} (\Xi^l_{ju})^{\frac{1}{\sigma-1}}}{\alpha(1-\alpha)^{\frac{1-\alpha}{\alpha}}} \tag{27}$$

We then have

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

where $\Xi^h_{ju} = 1 - \Xi^l_{ju}$. Intuitively, higher production floor prices, higher wages, and a higher share of skill s in total payroll all require higher productivity of skill s at 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 can calculate both urban and rural floor space:

$$\begin{aligned}
S^R_{ju} &= E[s_{ju}]H_{ju} = (1-\beta)\frac{E[v_{ju}]H_{ju}}{Q_{ju}} \\
&= \frac{1-\beta}{Q_{ju}}\left[w^l_{ju}H^l_{ju} + w^h_{ju}H^h_{ju}\right] + (1-\beta)S^R_{ju} \\
&= \frac{1-\beta}{\beta Q_{ju}}\left[w^l_{ju}H^l_{ju} + w^h_{ju}H^h_{ju}\right] \\
S^M_{ju} &= \left(\frac{(1-\alpha)}{q_{ju}}\right)^{\frac{1}{\alpha}} X_{ju} \\
S^R_{jr} &= \frac{1-\beta}{\beta Q_{jr}}\left[w_{jr}H_{jr}\right]
\end{aligned} \tag{29}$$

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

$$S_{ju} = S^R_{ju} + S^M_{ju} \tag{30}$$

and finally back out the construction intensity ϕ_j:

$$\phi_j = S_{ju}/L_j \tag{31}$$

C. Migration Costs

To compute migration costs, we need to first 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. Starting with the value of workers of skill s and sector n moving from i to j:

$$v_{in,jk}^s = w_{jk}^s + \frac{Q_{jn} S_{jn}^R}{H_{in}^R} \tag{32}$$

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

$$\Phi_{in}^s = \sum_{jk=11}^{JK} (\tau_{in,jk}^s Q_{jk}^{1-\beta})^{-\epsilon} (v_{in,jk}^s)^{\epsilon} = \frac{(Q_{jk}^{1-\beta})^{-\epsilon} (v_{in,in}^s)^{\epsilon}}{\pi_{in,in}^s} \tag{33}$$

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

$$\tau_{in,jk}^s = \frac{v_{in,jk}^s}{Q_{jk}^{1-\beta} (\pi_{in,jk}^s \Phi_{in}^s)^{1/\epsilon}} \text{, for } i \neq j \tag{34}$$

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 infinity.

5.3 Measured TFP in the Model

Based on the model solution, we can calculate measured total factor of productivity in the model. Unlike the fundamental skill-augmented labor productivities A_{ju}^h and A_{ju}^l, measured TFP in Olley and Pakes (1992) or Levinsohn and Petrin (2003) does not consider land as one of the production inputs. Further, data on land input costs at firm-level is not available, nor are the fundamental skill-augmented labor productivities A_{ju}^h and A_{ju}^l distinguishable in the data. Given all these limits, the measurement of urban TFP in the model which best matches the empirical analysis is:

$$\begin{aligned} ln(\widetilde{TFP}_{ju}) &= ln\left(\frac{Y_{ju}}{(H_{ju}^h + H_{ju}^l)^{\alpha}}\right) \\ &= \alpha ln\left(\frac{[(A_{ju}^h H_{ju}^h)^{\frac{\sigma-1}{\sigma}} + (A_{ju}^l H_{ju}^l)^{\frac{\sigma-1}{\sigma}}]^{\frac{\sigma}{\sigma-1}}}{H_{ju}^h + H_{ju}^l}\right) + (1-\alpha) ln(S_{ju}^M) \\ &= \underbrace{\frac{\sigma}{\sigma-1} ln(A_{ju}^l)}_{\text{fundamental}} + \underbrace{\frac{\sigma}{\sigma-1} ln\left((\frac{A_{ju}^h}{A_{ju}^l} \Gamma_{ju}^h)^{\frac{\sigma-1}{\sigma}} + (\Gamma_{ju}^l)^{\frac{\sigma-1}{\sigma}} \right)}_{\text{skill premium}} + \underbrace{(1-\alpha) ln(S_{ju}^M)}_{\text{land scale premium}} \end{aligned} \tag{35}$$

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, can be decomposed into four components: fundamental low-skill labor productivity, a skill premium from a higher share of high-skill workers (relative high-skill productivity), and a labor scale premium from a larger working population.

Table 5 shows a summary of the model results of measured TFP and its decomposition following equation (35) across regions. There are four observations. First, the major difference in measured TFP across regions is in the fundamentals. The more developed eastern cities have much higher fundamental productivity than non-eastern or less developed cities. Second, growth in measured TFP is mainly from growth in fundamental productivity rather than the other premiums. Third, eastern and more developed cities have higher land scale premiums due to their relatively large size, in terms of both population and land. Fourth, however, eastern and more developed cities do not necessarily have higher skill premiums.

We calculate 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 national-level weighted TFP by moving a low-skill worker from a small city to a big city. First, the fundamental term will increase since this worker migrates to a big city with higher low-skill productivity. Second, the change in the land scale premium is negative. This term is a concave function of S which means the marginal increment in big cities is smaller than the marginal deduction in small cities when one worker migrates to a big city. However, the fundamental term dominates the two premia in terms of magnitude, making it clear that having more workers in big cities can increase national weighted TFP.

5.4 Spatial Distribution of Land Tightness

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

The distribution is presented in Table 6. 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. Compared to non-eastern and less developed cities, eastern and more developed cities have on average 30% to 50% less land

Table 5: **Summary of Measured TFP in the Model**

Regions (location, development)	No. of Cities	2005 Total	2005 Fund	2005 SP	2005 LSP	2010 Total	2010 Fund	2010 SP	2010 LSP
National	225	38.17	35.31	0.66	2.19	40.43	37.52	0.70	2.22
(eastern, high)	8	40.15	37.28	0.62	2.26	42.08	39.29	0.50	2.29
(eastern, mid)	28	39.08	36.07	0.73	2.28	40.80	37.61	0.91	2.28
(eastern, low)	61	37.36	34.68	0.53	2.15	40.02	37.28	0.55	2.19
(non-eastern, mid)	9	37.74	34.83	0.83	2.08	40.05	37.04	0.88	2.13
(non-eastern, low)	119	36.85	34.06	0.69	2.10	39.72	36.87	0.70	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, 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 consistency in comparisons over time.

per worker. 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 6: **Spatial Distribution of Land Tightness**

Regions (location, development)	No. of Cities	Land/Worker (km^2/k) 2005	Land/Worker (km^2/k) 2010	Prod./Resid. (q_{ju}/Q_{ju}) 2005	Prod./Resid. (q_{ju}/Q_{ju}) 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 consistency in comparisons over time.

5.5 Remarks on the Quantitative Analysis

These patterns in measured TFP and the spatial distribution of land tightness indicate that there are potential gains in both productivity and equality 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 terms of fundamental productivity, such a land reallocation would attract more migration 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 a 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 the inland-favoring policy on workers' migration, land markets in different regions, TFP measures, and workers' income. We develop an iteration algorithm (global solution) 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

Land Supply: 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 new land quota increments from 2003 to 2005 and 2010 unchanged, but redistribute the total new land supply based on the land supply growth rate from 2000 to 2003.[17] The following equation shows the details of the new supply rule:

$$\widehat{L_j(t)} = L_j(2003) + \underbrace{\sum_j [L_j(t) - L_j(2003)]}_{\text{actual total increment of land}} \times \underbrace{\frac{L_j(2003)(1+g_{L_j})^{t-2003}}{\sum_j L_j(2003)(1+g_{L_j})^{t-2003}}}_{\text{city j's share if no inland-favoring}} \tag{36}$$

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 $\sum_j [L_j(t) - L_j(2003)]$ across the whole nation and city j's share of land supply if total land supply

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

followed the pre-2003 growth rate. 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.

Table 7: **Removing the 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 consistency in comparisons over time.

Table 8: **Removing the 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 consistency in comparisons over time.

Policy Summary: The counterfactual land allocation policy is summarized in Table 7 for total quantities of land supply and in Table 8 for relative measures of land supply. In Table 7 (8), columns 3-5 (3-4) shows the land supply data in the real world, and columns 6-7 (5-6) shows the land supply in the counterfactual world when we redistribute the land quota according to equation (36). In general, we find in Table 7 and 8 that if we keep the land allocation rule as it was 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 inland cities with low productivity in the same year.

6.2 Effects on Economic Development

We now show the effects of this counterfactual policy on economic development in terms of migration, output, and measured TFP.

Table 9: **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 consistency in comparisons over time.

Migration and Output: Table 9 illustrates some significant counterfactual outcome changes compared with the real world. First, columns 3-4 show that more workers migrate to urban areas in developed cities when more land is allocated to developed regions. Specifically, the urban low-skill (high-skill) population in eastern cities with high productivity increases by 14.3% (4.2%) in 2005 and by 17.2% (11.2%) in 2010. Conversely, less developed cities 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, columns 5-6 display the changes in floor space prices. The national average residential 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 20% decrease in the floor space price.[18] Third, columns 7-8 show the changes in the total output in different regions. We find an increase of about 2% in the total output of urban China. National-level output per capital also increases by the same level (column 9). Similar to previous outcomes, output in developed cities increases a lot, at the cost of a decrease in regions with lower productivity. We find a 19.1% increase in total output in eastern cities with high development, but a 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 underdeveloped areas is due to the loss in the population.

Table 10: **Removing the Inland-favoring Policy: Measured TFP**

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

Measured TFP: Table 10 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 national-level TFP substantially by 6.2% in 2005 and by

[18] Lu, Zhang, and Liang (2015) uses a regression-based method and finds similar results, namely that the 2003 policy resulted in a relative increase in housing costs in the eastern area.

7.3% in 2010. The decomposition also shows that most of the national TFP gains are driven by the increase in the fundamental productivity term. The reform encourages more workers to migrate to developed regions with higher 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 underdeveloped cities due to the land losses. For instance, TFP in non-eastern cities with medium and low productivity declines by 10.4% and 4.9%, respectively. This result shows that although national TFP and output would be higher with the pre-2003 land allocation policy, it appears that regional productivity gaps will also increase.

6.3 Effects on Worker Income

In the previous subsection, we find that regional inequality in productivity and output will widen if we remove the inland-favoring land supply policy. It seems that the inland-favoring land policy did help to reduce regional gaps. However, this is just an illusion. In this subsection, we show the effects on the incomes of workers from different places.

Panel (A) and (B) in Table 11 show the changes in wages and total income for workers from different hometowns (Hukou registered locations). We find that in the counterfactual world, wages for workers of all origins are higher than in the 2005 real world data. Specifically, workers from non-eastern inland cities with low productivity gain the most, with a 2.4% increase in their wages. In terms of total income, it also increases for workers from almost all regions. The only difference is that total income increases more for citizens from developed cities since their increased land allocations increases their housing income. Similarly, in 2010, workers from cities with low productivity have higher incomes without the inland-favoring policy. Thus, the inland-favoring land policy in 2003 did not help workers from underdeveloped areas, but actually hurt them by reducing their wages and incomes.

In general, these results imply that even though it seems that the inland-favoring land supply policy achieved its original goal of shrinking regional output gaps, it actually hurt workers from underdeveloped areas. Income of people from almost all places were decreased and the convergence of the income is because people from developed regions were hurt more.

Table 11: **Removing the Inland-favoring Policy: Worker Incomes**

Regions (location, development)	No. of Cities	Hukou-based Income 2005	$\widehat{2005}$	Changes	2010	$\widehat{2010}$	Changes
(A) Hukou-based Average Wage Income							
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%
(B) Hukou-based Average Total Income							
National	225	19.0	19.2	1.10%	36.9	37.3	1.04%
(eastern, high)	8	44.5	46.9	5.22%	84.9	92.7	9.14%
(eastern, mid)	28	28.7	28.7	0.20%	52.7	53.4	1.42%
(eastern, low)	61	16.1	16.2	0.59%	32.8	32.9	0.50%
(non-eastern, mid)	9	20.6	20.6	-0.05%	40.9	39.5	-3.58%
(non-eastern, low)	119	15.4	15.6	1.34%	31.8	32.0	0.37%

Notes: This table displays a summary of Hukou-based average wage income and total income by group (weighted by Hukou population) 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 consistency in comparisons over time.

6.4 Remarks on Eliminating the Inland-favoring Land Policy

Generally speaking, our counterfactual results show that the inland-favoring land supply policy resulted in a severe misallocation of both land and labor. It increased the price of residential and production floor space and discouraged workers from underdeveloped cities from migrating to developed cities. This led to a loss in national-level output and TFP.

The observed regional convergence is just an illusion. It seems that regional output and productivity gaps were reduced, which was precisely the government's original goal. However, workers from both developed and under-developed regions suffered. The income gap was reduced not because the income of people from poor areas increased, but because everyone's income decreased and people from rich areas were hurt more. This placed-based land policy paradoxically helps regions but harms people from those regions. We show in the next section that we can achieve real convergence in living standards using a direct regional transfer policy without efficiency losses, which can help people from poor areas.[19]

[19] Another interesting point is to consider the welfare changes in terms of expected utility. We briefly discuss this

Our baseline model and counterfactual above consider the spatial economy without any agglomeration effects. However, literature such as Combes, Duranton, and Gobillon (2008) and Ahlfeldt et al. (2015) show that the density of population has significant positive effects on local productivity and local wages. We introduce agglomeration effect in Appendix E and calculate the counterfactuals. We find that the agglomeration effect amplifies the gains from removing the inland-favoring land policy.

7 Direct Transfers Instead of Land Policy

In this section, we simulate a regional direct transfer policy without land quota changes. 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 as in Section 6. The central government, instead, chose to transfer the additional land income generated from developed cities to underdeveloped cities to satisfy its redistribution motive.

7.1 Constructing the Counterfactual Policy

First, we keep the total land quota increments from 2003 to 2005 and 2010 unchanged, but we redistribute the total land supply increment based on the pre-2003 land supply growth rate as in Section 6. Then, the central government taxes land income and wage income from land-gaining developed cities and subsidizes land-losing under-developed cities according to their changes in land allocation.[20] All Hukou registered people in land-losing under-developed cities receive the corresponding subsidy. The subsidy is higher in cities losing more land, with higher floor space prices, and with higher wages. The subsidy compensates for only a fraction of the losses, and the transfer proportion is a tuning parameter for policy makers. We have infinite choices for the tuning parameters but show the results from one set of choices for exposition. We also choose some other set of parameters and the results are similar. Please refer to Appendix C.1 for a detailed discussion about the transfer rule and tuning parameters.[21]

issue in Appendix D.

[20] For instance, in a two city example, subtracting land supply in the underdeveloped city i and reallocating to the developed city j affects income of workers Hukou-registered in city i (opposite for city j) in both income components: less residential floor space income and lower Hukou city's wage income due to less production floor space. Therefore, we could partially subtract the additional income from the additional land allocated to land-gaining cities and compensate land-losing cities for their losses to achieve the redistribution motive.

[21] We do not discuss the optimal redistribution rule for two reasons. First, finding the optimal redistribution rule is computationally impossible because of the infinite dimensions of the redistribution problem caused by the number of cities, continuous choice of transfer in each city, and the nonlinear interactions among agents. Second, the intention

7.2 Effects on Worker Incomes

The effects of this counterfactual policy on economic development in migration, output, and measured TFP are very similar to the first counterfactual. Thus, we will not discuss them in details. Details are in Appendix C.2. The main idea is that, compared to the inland-favoring policy, a pre-2003 land supply scheme with a direct transfer can increase regional migration, national output, and TFP, and also reduce average housing costs. The direct transfer policy leads to much less spatial distortion or misallocation of resources, compared with the inland-favoring land policy. Now we discuss the effects on worker's incomes.

Table 12: **Direct Transfer Instead of Land Policy: Workers' Incomes**

Regions (location, development)	No. of Cities	Hukou-based Income 2005	$\widehat{2005}$	Changes	2010	$\widehat{2010}$	Changes
(A) Hukou-based Average Wage Income							
National	225	14.6	14.8	0.97%	28.5	28.6	0.49%
(eastern, high)	8	26.1	26.2	0.36%	40.6	40.3	-0.60%
(eastern, mid)	28	20.8	20.8	-0.01%	36.3	36.2	-0.40%
(eastern, low)	61	12.9	13.0	1.08%	26.3	26.6	0.83%
(non-eastern, mid)	9	16.0	16.0	0.09%	30.4	29.7	-2.38%
(non-eastern, low)	119	12.6	12.8	1.63%	26.5	26.7	0.93%
(B) Hukou-based Average Total Income							
National	225	19.0	19.1	0.50%	36.9	37.3	1.09%
(eastern, high)	8	44.5	39.1	-12.21%	84.9	66.2	-22.01%
(eastern, mid)	28	28.7	27.5	-4.00%	52.7	49.6	-5.77%
(eastern, low)	61	16.1	15.9	-1.10%	32.8	33.7	2.88%
(non-eastern, mid)	9	20.6	20.4	-0.73%	40.9	45.1	10.21%
(non-eastern, low)	119	15.4	16.5	6.80%	31.8	33.7	5.93%

Notes: This table displays a summary of Hukou-based average wage income and total income by group (weighted by Hukou population) 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 consistency in comparisons over time.

Table 12 shows the results on incomes of workers from different home cities. Compared to the real world, when we replace the inland-favoring land policy with a direct transfer, we increase the total income of workers from the least developed regions by 6.8% in 2005 and 5.9% in 2010. On the contrary, the total income of workers from highly developed cities is reduced by 12.2% in

of our paper is not about designing the optimal rule but showing that the current land policy is neither efficient nor equal. Therefore, we show just a simple rule which performs better in both efficiency and equality. For discussion about optimal spatial policy, please refer to Hsieh and Klenow (2009) and Fajgelbaum and Gaubert (2020).

2005 and 22.0% in 2010. The wage income of workers from under-developed areas also increases in both years because more move to developed eastern cities with higher wages. Therefore, this direct transfer policy achieves real convergence by increasing both the wages and total incomes of workers from less developed cities.

Generally speaking, using a direct regional transfer instead of the inland-favoring land policy can not only result in a more efficient resource allocation, but also achieve real convergence by increasing incomes of workers from underdeveloped cities.[22]

8 Conclusion

This paper studies how regulated land allocation policy creates spatial misallocation. We focus on a major policy change favoring less developed inland regions in China, which is intended to balance regional growth between the developed eastern regions and the underdeveloped inland 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 resulted because developed eastern regions have higher productivity and the reduced land supply also reduced migration to these high productivity areas. Counterfactual simulations of eliminating this inland-favoring policy suggest resolving this spatial misallocation would increase national-level productivity and output.

Moreover, at the cost of sacrificing national-level productivity and output, the inland-favoring policy actually hurt workers from underdeveloped regions. By eliminating this policy change, the income of workers from poorer underdeveloped regions would increase through more migration to developed regions. Even though the inland-favoring policy reduced regional output gaps, it in fact caused TFP and output losses, and unfavorably hurt workers from under-developed regions by hindering their access to higher-paid developed regions.

Finally, we suggest a direct regional transfer to replace the inland-favoring land supply policy. By keeping the pre-2003 land allocation rule and transferring additional income from developed regions to underdeveloped regions, we can achieve real convergence by increasing incomes for workers from underdeveloped regions without efficiency losses or spatial misallocation.

[22] We also consider the welfare changes in terms of expected utility. We briefly discuss this issue in Appendix D.

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Appendix

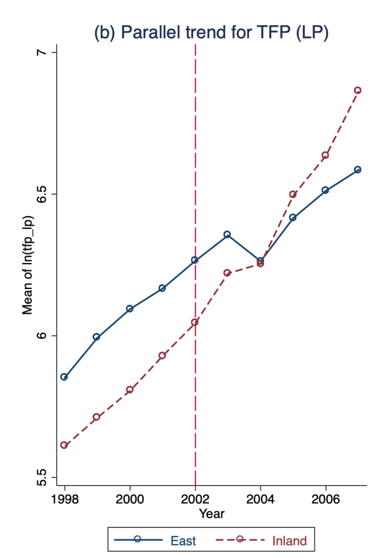
A Empirical Appendix

A.1 Additional Robustness Checks

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

First, we implement the empirical analysis using firm-level TFP calculated through the LP method. Figure A1 and A2 show the parallel trend test. Table A1 shows the results of the main regression. All results are very similar to the results when we calculate TFP using the OP method.

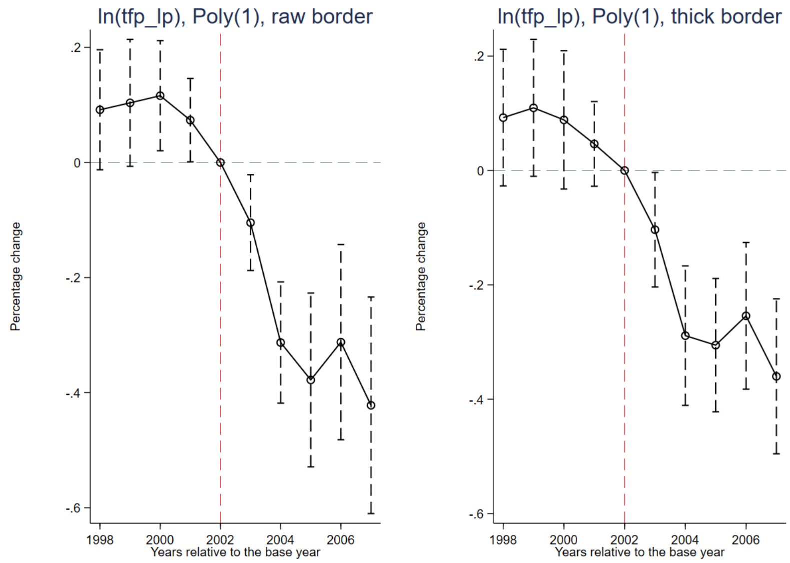
Figure A1: Parallel Trend of Outcome Variables



Notes: This figure shows the time trends of firm-level TFP calculated using the LP 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. The dashed vertical line is put at the year 2002, just before the implementation of the inland-favoring land policy. It is clear that both outcome variables have very similar trends before the policy.

Second, we drop Liaoning, Hebei, and their neighboring 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 Liaoning, Hebei, and their neighboring inland cities from our sample. Table A2, A3, and A4 show that our results are robust to this change.

Figure A2: Event Study - TFP (LP)



Notes: The dependent variable is firm-level TFP calculated by the LP method. The bandwidth is 80 km from the border of the eastern and non-eastern classifications. The confidence interval is 95%.

Third, we change the bandwidth for the linear and quadratic fit.[23] We show results from two other bandwidth choices, 70 km and 90 km. Table A5 to A7 show the results for land prices and firm-level TFP measured by both the LP and OP methods. The results are very robust compared with the main regressions.

Fourth, the Chinese central government did not require local governments to upload all of their land transaction information to the China Land Market Website until 2006. Thus, there was a drastic increase in the number of land parcels in our data after 2006. There is thus a concern that the sample after 2006 could be very different from the samples before 2006. Thus, we check robustness by dropping all data after 2006 in the land price regression. The results are shown in Table A8. We find no quantitative change.

Fifth, China entered the WTO at the end of 2001, which dramatically changed China's economic structure. Although this is about two years before the inland-favoring land supply policy, we are still concerned about possible confounding from this reduction in trade barriers, which may have affected eastern and non-eastern firms differently. To address this issue, we run the TFP regression keeping only firms with zero exports. These firms should be the ones that are affected the least by entering the WTO. The regression results are shown in Tables A9 and A10. The main

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

conclusions are still sustained.

Sixth, we run all main regressions without city-level lagged control variables. Table A11, A12 and A13 show that the estimation results are very similar to regressions with control variables. It implies that adding city characteristics does not affect the regression results, which further validates the assumption that the cities at the border have similar trends.

Table A1: 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 firm-level TFP measured by the 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 value added of the service sector. The sample in the Local Linear regression specification is restricted to be within an optimal bandwidth using a constant kernel. The sample for the Polynomial RD cases 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: 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. The sample in the Local Linear regression specification is restricted to be within an optimal bandwidth using a constant kernel. The sample in the Polynomial RD cases 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 (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 firm-level TFP measured by the 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. The sample in the Local Linear regression specification is restricted to be within an optimal bandwidth using a constant kernel. The sample in the Polynomial RD cases 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: TFP Regressions without Liaoning and Hebei (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	0.546***	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 firm-level TFP measured by the 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. The sample in the Local Linear regression specification is restricted to be within an optimal bandwidth using a constant kernel. The sample in the Polynomial RD cases 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 A5: Robustness: Land Prices Regressions with Different Bandwidth Choices

	Polynomial RD (Poly=1)		Polynomial RD (Poly=2)	
	bandwidth=70km (1)	bandwidth=90km (2)	bandwidth=70km (3)	bandwidth=90km (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 A6: Robustness: TFP Regressions with Different Bandwidth Choices (LP)

	Polynomial RD (Poly=1)		Polynomial RD (Poly=2)	
	bandwidth=70km (1)	bandwidth=90km (2)	bandwidth=70km (3)	bandwidth=90km (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 firm-level TFP measured by the 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 A7: Robustness: TFP Regressions with Different Bandwidth Choices (OP)

	Polynomial RD (Poly=1)		Polynomial RD (Poly=2)	
	bandwidth=70km (1)	bandwidth=90km (2)	bandwidth=70km (3)	bandwidth=90km (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 firm-level TFP measured by the 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 * $p < 0.1$.

Table A8: Robustness: Land Prices Regressions Before 2006

	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	-5.767***	-9.208**	-3.818***	-3.311***	-5.906**	-6.338***
	(1.314)	(3.443)	(1.042)	(0.811)	(2.935)	(1.639)
Post2003×east	5.771***	9.017**	4.032***	3.567***	5.552*	6.266***
	(1.339)	(3.428)	(1.013)	(0.779)	(2.815)	(1.744)
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	11683	4967	14848	13671	14848	13671
Adjusted R-squared	0.146	0.170	0.132	0.139	0.136	0.145

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. The sample in the Local Linear regression specification is restricted to be within an optimal bandwidth using a constant kernel. The sample in the Polynomial RD cases is restricted to be within a bandwidth of 80 km around the raw boundary. We drop all samples after 2006. *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.

Table A9: Robustness: TFP Regressions without Exporting Firms (LP)

	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	0.355***	0.232***	0.425***	0.374***	0.383***	0.337***
	(0.098)	(0.081)	(0.053)	(0.051)	(0.071)	(0.073)
Post2003×East	-0.550***	-0.269**	-0.408***	-0.331***	-0.516***	-0.343***
	(0.135)	(0.102)	(0.078)	(0.054)	(0.116)	(0.087)
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	49617	37511	195068	176822	195068	176822
Adjusted R-squared	0.122	0.124	0.113	0.112	0.113	0.112

Notes: The dependent variable is firm-level TFP measured by the 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. The sample in the Local Linear regression specification is restricted to be within an optimal bandwidth using a constant kernel. The sample in the Polynomial RD cases is restricted to be within a bandwidth of 80 km around the raw boundary. We drop all firms with export. *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.

Table A10: Robustness: TFP Regressions without Exporting Firms (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	0.477***	0.324***	0.401***	0.344***	0.459***	0.333***
	(0.099)	(0.076)	(0.043)	(0.046)	(0.058)	(0.068)
Post2003×East	-0.495***	-0.190	-0.316***	-0.240***	-0.432***	-0.261***
	(0.086)	(0.114)	(0.055)	(0.052)	(0.073)	(0.087)
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	32013	35184	195068	176822	195068	176822
Adjusted R-squared	0.206	0.186	0.176	0.175	0.177	0.175

Notes: The dependent variable is firm-level TFP measured by the 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. The sample in the Local Linear regression specification is restricted to be within an optimal bandwidth using a constant kernel. The sample in the Polynomial RD cases is restricted to be within a bandwidth of 80 km around the raw boundary. We drop all firms with export. *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.

Table A11: Robustness: Land Prices Regressions without City-level Controls

	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	-5.215***	-9.165**	-3.502***	-3.108***	-4.478	-5.408***
	(1.429)	(3.454)	(1.156)	(0.945)	(2.747)	(1.753)
Post2003×East	5.394***	9.455***	3.774***	3.399***	4.636*	5.630***
	(1.420)	(3.447)	(1.153)	(0.941)	(2.731)	(1.759)
City Lagged Controls	N	N	N	N	N	Y
Border FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Observations	132145	57338	174099	159473	174099	159473
Adjusted R-squared	0.058	0.065	0.053	0.053	0.054	0.054

Notes: The dependent variable is the land parcel-level price. We do not control for the set of lagged city level control variables. The sample in the Local Linear regression specification is restricted to be within an optimal bandwidth using a constant kernel. The sample for the Polynomial RD cases 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 A12: Robustness: TFP Regressions without City-level Controls (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	0.495***	0.333***	0.460***	0.400***	0.503***	0.410***
	(0.078)	(0.073)	(0.060)	(0.048)	(0.090)	(0.070)
Post2003×East	-0.534***	-0.339***	-0.394***	-0.347***	-0.483***	-0.392***
	(0.100)	(0.091)	(0.064)	(0.051)	(0.085)	(0.081)
City Lagged Controls	N	N	N	N	N	N
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	0.094	0.097	0.086	0.086	0.086	0.086

Notes: The dependent variable is firm-level TFP measured by the LP method. We do not control for the set of lagged city level control variables. The sample in the Local Linear regression specification is restricted to be within an optimal bandwidth using a constant kernel. The sample for the Polynomial RD cases 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 A13: Robustness: TFP Regressions without City-level Controls (OP)

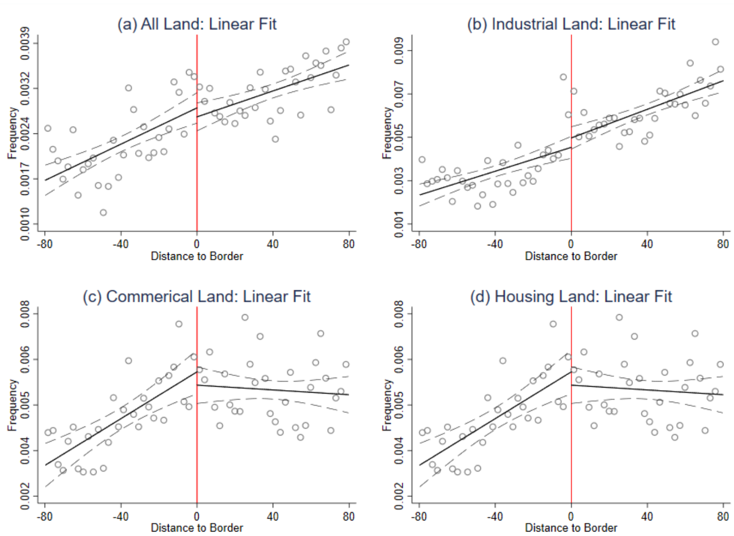
	Local Linear		Polynomial RD (Poly=1)		Polynomial RD (Poly=2)	
	Raw Border (1)	Thick Border (2)	Raw Border (3)	Thick Border (4)	Raw Border (5)	Thick Border (6)
East	0.643***	0.447***	0.489***	0.387***	0.598***	0.388***
	(0.062)	(0.070)	(0.067)	(0.047)	(0.080)	(0.070)
Post2003×East	-0.479***	-0.260**	-0.315***	-0.248***	-0.410***	-0.258***
	(0.066)	(0.101)	(0.051)	(0.051)	(0.061)	(0.082)
City Lagged Controls	N	N	N	N	N	N
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	0.166	0.154	0.140	0.141	0.141	0.141

Notes: The dependent variable is firm-level TFP measured by the LP method. We do not control for the set of lagged city level control variables. The sample in the Local Linear regression specification is restricted to be within an optimal bandwidth using a constant kernel. The sample for the Polynomial RD cases is restricted to be within a bandwidth of 80 km around the raw boundary. *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.

A.2 More Regression Assumption Validations

Apart from the parallel trend assumption, there is another 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 pieces 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 governments may choose to develop all of their land at the border for some reason while eastern governments may not. If this manipulation occurs, we may not be able to assume that the land parcels just on the eastern side of the border have similar trends with the ones just on the non-eastern side. Figure A3 shows the distribution of the sold land parcels. We also separate the figures by land usage. The figure illustrates that for all kinds of land parcels, there is no evidence of discontinuities in their distribution at the border. Similarly, Table A14 shows the balance of some pre-determined land parcel characteristics, including elevation, slope and ruggedness. We test whether there is any jumps 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, we judge the land parcels at the border to be comparable.

Figure A3: Distribution of Land Parcels



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

Table A14: 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. The sample in local linear regression specification is restricted to be within an optimal bandwidth using a constant kernel. The sample in the Local Linear regression specification is restricted to be within an optimal bandwidth using a constant kernel. The sample in the Polynomial RD cases 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 * $p < 0.1$.

B Algorithm for Counterfactual Analysis

Given the exogenous variables and parameters, we need to calculate the responses of endogenous variables resulting from model policy changes. As mentioned, we select the equilibrium that is the closest to the one observed in the real world. Thus, the initial values of the variables are set equal to the data in 2005 and 2010 . Since we have a within-city land market between residential and production uses, 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 are $\{H_i^s, \epsilon_j^s, \tau_{ij}^s, L_j, \phi_j, \eta_j\}$ where i index Hukou city, j indexes destination city, and s indexes 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 policy changes, we start with the block in which the changes happens, and then iterate block by block to update the endogenous variables until all endogenous variables converge within certain small thresholds. We present the process of calculating a counterfactual of increasing 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 the t^{th} iteration of variable x. Let's start with the housing block to initiate the process (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 uses according to the inner loop equilibrium unit prices of residential and production floor space. The outer loop converges when the prices satisfy the equilibrium price equation between both markets.

Step 1: Initiation (ensuring non-zero floor space supply)

$$\{\hat{S_{ju}}\}^* = \phi_j \hat{L}_j \tag{37}$$

$$\{\hat{S_{ju}^R}\}^1 = S_{ju}^R \times (\{\hat{S_{ju}}\}^* / S_{ju}) \tag{38}$$

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

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

$$\{\hat{Q}_{ju}\}^{\mathbf{1}^*} = \frac{1-\beta}{\beta}\frac{\{w^l_{ju}H^l_{ju} + w^h_{ju}H^h_{ju}\}^{\mathbf{1}^*}}{\{\hat{S}^R_{ju}\}^1} \tag{40}$$

$$\{\hat{q}_{ju}\}^{\mathbf{1}^*} = (1-\alpha)\left(\frac{\alpha}{\{\hat{W}_{ju}\}^{\mathbf{1}^*}}\right)^{\frac{\alpha}{1-\alpha}} \tag{41}$$

Step 3: Compare floor space prices and generate excess demand for residential space. 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.

$$\{ED^R_j\}^1 = \gamma\left(\frac{\{\hat{Q}_{ju}\}^{\mathbf{1}^*} - \frac{\{\hat{q}_{ju}\}^{\mathbf{1}^*}}{\eta_j}}{\{\hat{Q}_{ju}\}^{\mathbf{1}^*} + \frac{\{\hat{q}_{ju}\}^{\mathbf{1}^*}}{\eta_j}}\right) \times \{\hat{S}^R_{ju}\}^1 \tag{42}$$

Step 4: Update floor space

$$\{\hat{S}^R_{ju}\}^2 = \{\hat{S}^R_{ju}\}^1 + \{ED^R_j\}^1 \tag{43}$$

$$\{\hat{S}^M_{ju}\}^2 = \{\hat{S}^M_{ju}\}^1 - \{ED^R_j\}^1 \tag{44}$$

Finally, we repeat Step 2 to Step 4 until the 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 with 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 the housing block

$$\{\hat{Q}_{ju}\}^{11} = \frac{1-\beta}{\beta}\frac{w^l_{ju}H^l_{ju} + w^h_{ju}H^h_{ju}}{\{\hat{S}^R_{ju}\}^1} \tag{45}$$

$$\{\hat{Q}_{jr}\}^{11} = \tau\{\hat{Q}_{ju}\}^{11} \tag{46}$$

$$\{S^R_{jr}\}^{11} = \frac{1-\beta}{\beta}\frac{w_{jr}H_{jr}}{\{\hat{Q}_{jr}\}^{11}} \tag{47}$$

Step 2-2: Update the migration block

$$\{\hat{v^s_{in,jk}}\}^{11} = w^s_{jk} + \frac{\{\hat{Q}_{in}\}^{11}\{\hat{S}^R_{in}\}^{11}}{H^R_{in}} \quad \text{from eq.(6)} \tag{48}$$

$$\{\hat{\pi^s_{in,jk}}\}^{11} = \frac{(\tau^s_{in,jk}\{\hat{Q}_{jk}\}^{11^{1-\beta}})^{-\epsilon}(\{\hat{v^s_{in,jk}}\}^{11})^{\epsilon}}{\sum_{j'k'=11}^{JK}(\tau^s_{in,jk}\{\hat{Q}_{j'k'}\}^{11^{1-\beta}})^{-\epsilon}(\{\hat{v^s_{in,j'k'}}\}^{11})^{\epsilon}} \text{ from eq.(12)} \tag{49}$$

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 the production block

$$\{\hat{X}_{ju}\}^{11} = [(\{A^h_{ju}\}^{11}\{\hat{H}^h_{ju}\}^{11})^{\frac{\sigma-1}{\sigma}} + (\{A^l_{ju}\}^{11}\{\hat{H}^l_{ju}\}^{11})^{\frac{\sigma-1}{\sigma}}]^{\frac{\sigma}{\sigma-1}} \text{ from eq.(13)} \tag{50}$$

$$\{\hat{w}^l_{ju}\}^{11} = \alpha(\{\hat{X}_{ju}\}^{11})^{\alpha-1}(\{\hat{S}^M_{ju}\}^{1})^{1-\alpha}(\{A^l_{ju}\}^{11})^{\frac{\sigma-1}{\sigma}}(\{\hat{X}_{ju}\}^{11})^{\frac{1}{\sigma}}(\{\hat{H}^l_{ju}\}^{11})^{-\frac{1}{\sigma}} \text{ from eq.(14)} \tag{51}$$

$$\{\hat{w}^h_{ju}\}^{11} = \alpha(\{\hat{X}_{ju}\}^{11})^{\alpha-1}(\{\hat{S}^M_{ju}\}^{1})^{1-\alpha}(\{A^h_{ju}\}^{11})^{\frac{\sigma-1}{\sigma}}(\{\hat{X}_{ju}\}^{11})^{\frac{1}{\sigma}}(\{\hat{H}^h_{ju}\}^{11})^{-\frac{1}{\sigma}} \text{ from eq.(15)} \tag{52}$$

Step 2-4: Update prices

$$\{\hat{Q}_{ju}\}^{12} = \frac{1-\beta}{\beta}\frac{\{w^l_{ju}H^l_{ju} + w^h_{ju}H^h_{ju}\}^{11}}{\{\hat{S}^R_{ju}\}^{1}} \tag{53}$$

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.

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

$$\{\hat{W}_{ju}\}^{11} = \frac{\{\hat{w}^h_{ju}\}^{11}\{\hat{H}^h_{ju}\}^{11} + \{\hat{w}^l_{ju}\}^{11}\{\hat{H}^l_{ju}\}^{11}}{\{\hat{X}_{ju}\}^{11}} \tag{55}$$

$$\{\hat{q}_{ju}\}^{1*} = (1-\alpha)\left(\frac{\alpha}{\{\hat{W}_{ju}\}^{1*}}\right)^{\frac{\alpha}{1-\alpha}} \tag{56}$$

C Direct Transfers Instead of Land Policy

C.1 Details of Transfer Rules

Without loss of generality, we design a direct transfer rule as follows for each city i:

$$\hat{DT}_{iu} = \underbrace{\hat{Q}_{iu}\hat{S}^R_{iu} \times \gamma^l_u \times \frac{-\Delta L_i}{L_i}}_{\text{urban land income transfer}} + \underbrace{(\hat{w}^l_{iu}H^l_{iu} + \hat{w}^h_{iu}H_{iu^h}) \times \gamma^w_u \times \frac{-\Delta L_j}{L_j}}_{\text{urban wage income transfer}}$$

$$\hat{DT}_{ir} = \underbrace{(\hat{w}_{ir}H_{ir}) \times \gamma_r \times \frac{-\Delta L_j}{L_j}}_{\text{rural wage income transfer}}$$

where $\hat{DT}_{iu}$ stands for direct transfer to urban workers and $\hat{DT}_{ir}$ stands for direct transfer to rural workers. For a city losing $\frac{\Delta L_i}{L_i}$ (<0) of its land, urban workers will be compensated with a fraction γ^l_u of their floor space income $\hat{Q}_{iu}\hat{S}^R_{iu}$, and a fraction γ^w_u of their opportunity wage income $(\hat{w}^l_{iu}H^l_{iu} + \hat{w}^h_{iu}H_{iu^h})$. Since rural workers also face losses in their opportunity wage income for losing access to their closest urban sector (the urban sector in their own city), they will be compensated with a fraction γ_r of their indirect opportunity wage income $\hat{w}_{ir}H_{ir}$. These direct transfers are possible to implement because land-gaining cities ($\frac{\Delta L_i}{L_i} > 0$) have much higher floor space prices and wages. The scale of the transfer depends on the tuning parameters $\{\gamma^l_u, \gamma^w_u, \gamma_r\}$. As we mentioned, we are not planning or able to discuss the optimal redistribution policy design in this paper, therefore, we show the results from one set of tuning parameters $\{\gamma^l_u, \gamma^w_u, \gamma_r\} = \{0.5, 0.1, 0.5\}$ for 2010 and $\{\gamma^l_u, \gamma^w_u, \gamma_r\} = \{0.75, 0.1, 0.5\}$ for 2005 which are sufficient to generate substantial redistribution. We also choose some other set of parameters and the results are similar.

This counterfactual is feasible to implement and still fulfills the central government's goal of balancing regional development. This mechanism mimics a policy called the "land quota market", which has been recommended by previous literature (Lu and Xiang, 2016). The basic idea is that the central government can balance the development of different regions by transferring revenues from developed cities to underdeveloped cities, rather than allocating the land supply directly. Since land and wage incomes in land-gaining cities are higher than in land-losing cities, and the total amount of land supply is unchanged, this redistribution is feasible and the central government can even generate additional profit.

C.2 More Results of Counterfactual with Transfer

Table D1: **Direct Transfer Instead of Land 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	0.0%	1.0%	-3.9%	-3.9%	2.0%	-0.9%	1.1%
(eastern, high)	8	5.3%	13.9%	-22.8%	-22.8%	12.4%	0.4%	-0.2%
(eastern, mid)	28	0.6%	0.5%	-6.5%	-6.5%	0.5%	-0.4%	0.0%
(eastern, low)	61	-1.1%	-0.9%	-0.2%	-0.2%	-1.1%	-1.0%	-0.1%
(non-eastern, mid)	9	-0.9%	-0.8%	5.9%	5.9%	-1.4%	0.0%	-0.6%
(non-eastern, low)	119	-2.2%	-1.6%	-1.5%	-1.5%	-1.9%	-0.9%	-0.1%
Panel B: Percentage Changes in $\widehat{2010}$								
National	225	0.0%	0.0%	-8.3%	-8.3%	0.8%	0.0%	0.8%
(eastern, high)	8	11.3%	13.1%	-25.5%	-25.5%	15.8%	-0.9%	2.6%
(eastern, mid)	28	4.1%	3.1%	-23.8%	-23.8%	4.2%	2.4%	0.9%
(eastern, low)	61	-3.4%	-3.4%	7.4%	7.4%	-4.6%	0.1%	-1.2%
(non-eastern, mid)	9	-7.8%	-9.6%	24.9%	24.9%	-14.2%	0.0%	-5.6%
(non-eastern, low)	119	-4.7%	-6.2%	2.8%	2.8%	-8.3%	-0.5%	-2.5%

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 consistency of comparisons over time.

Table D2: **Direct Transfer Instead of Land Policy: Measured TFP**

Regions	No. of	2005				2010			
(location, development)	Cities	Total	Fund	SP	LSP	Total	Fund	SP	LSP
National	225	5.4%	4.5%	-0.3%	1.2%	5.3%	5.6%	-0.4%	0.1%
(eastern, high)	8	7.3%	8.1%	-4.9%	4.3%	10.9%	8.2%	-2.8%	5.5%
(eastern, mid)	28	-1.3%	-2.0%	0.0%	0.7%	0.7%	-0.3%	0.0%	1.1%
(eastern, low)	61	0.2%	-0.1%	0.1%	0.3%	-1.7%	0.0%	-0.2%	-1.5%
(non-eastern, mid)	9	-0.3%	0.5%	-0.2%	-0.5%	-9.9%	-5.2%	-0.2%	-4.8%
(non-eastern, low)	119	0.4%	0.4%	0.2%	-0.2%	-5.2%	-0.4%	-2.2%	-2.7%

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, 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 consistency of comparisons over time.

D Discussion on Utility Implications

D.1 Calculation of the Utility

In this section, we briefly discuss the utility changes of workers. We relegate this discussion to the appendix since we believe the results can only be suggestive. First, utility is fundamentally ordinal. Thus, the aggregation of utilities across people with different characteristics from different regions is not innocuous. We do not know how to assign weights to different people. Second, the aggregation results depend heavily on the functional form of utility. As a result, we focus on income changes in the main paper. This section can only give some suggestive implications for the policy effect on workers.

We can calculate the ex-ante expected utility of workers based on the properties of a Fréchet distribution. The cumulative distribution function of the utility of workers originating from city i sector n with skill s is

$$G_{in}^{s}(u) = e^{-\Phi_{in}^{s} u^{-\epsilon}}, \ \Phi_{in}^{s} = \sum_{j'k'=11}^{JK} (\tau_{in,j'k'}^{s} Q_{j'k'}^{1-\beta})^{-\epsilon} (v_{in,j'k'}^{s})^{\epsilon}$$

with their expected utility as:

$$\mathbf{E}_{in}^{s}[u] = \Gamma\left(1 - \frac{1}{\epsilon}\right) \times {\Phi_{in}^{s}}^{\frac{1}{\epsilon}}$$

where the Gamma function $\Gamma\left(1 - \frac{1}{\epsilon}\right)$ is a constant number and Φ_{in}^{s} reflects the expected utility from accesses to all alternative cities and sectors. This choice set value is positively correlated with potential income $v_{in,j'k'}^{s}$ and is negatively correlated with migration and housing costs. We then calculate the changes in utility as:

$$\Delta\mathbf{E}_{in}^{s}[u] = \frac{\hat{\mathbf{E}_{in}^{s}[u]}}{\mathbf{E}_{in}^{s}[u]} - 1 \tag{57}$$

D.2 Utility Changes in the First Counterfactual

Table F1 shows the utility changes in our first counterfactual. Each row refers to a group of Hukou registered home locations with some development level. Each column refers to a group of Hukou type (rural or urban) and skill type. When we remove the inland-favoring land policy, the total utility of the nation increases by 3.44% in 2005 and by 10.87% in 2010. The utility of workers from developed areas is increased a lot in both years. Meanwhile, the utility of workers from under-developed areas increases in 2005 but decreases in 2010, with smaller magnitudes. In

2010, the changes in the utility of workers from poor areas are the opposite sign of the changes in total income (shown in Table 11). One possible reason is that developed cities are usually far away from underdeveloped areas. The removal of the inland-favoring policy allocates more land to developed regions and makes the urban sector of less developed regions less accessible. Then some formerly short-distance migrants have to migrate to big cities far away and pay more migration costs. If this migration cost increment dominates the income increment, then we may see a decrease in utility.

Thus, in conclusion, the inland-favoring land supply policy reduces the total utility of the whole country in both 2005 and 2010. It decreases utility for almost everyone in 2005, but increases utility for workers from underdeveloped areas in 2010.

Table F1: **Removing Inland-favoring Policy: Regional Utility**

Regions (location, development)	No. of Cities	Hukou-based Utility Changes (R/U, skill) All	(Rural, Low)	(Rural, High)	(Urban, Low)	(Urban, High)
Utility Changes in 2005						
National	225	3.44%	1.12%	4.39%	1.34%	1.94%
(eastern, high)	8	13.70%	2.91%	21.80%	13.98%	13.40%
(eastern, mid)	28	-1.63%	0.09%	-2.28%	0.15%	0.69%
(eastern, low)	61	0.31%	0.24%	0.36%	0.06%	-0.08%
(non-eastern, mid)	9	0.74%	-1.03%	1.98%	-1.73%	-1.16%
(non-eastern, low)	119	1.24%	-0.58%	1.82%	-0.46%	-1.26%
Utility Changes in 2010						
National	225	10.87%	12.65%	9.15%	-0.49%	2.39%
(eastern, high)	8	18.97%	18.64%	19.87%	21.37%	28.76%
(eastern, mid)	28	-1.14%	-3.62%	-0.78%	0.74%	2.39%
(eastern, low)	61	-2.28%	-2.16%	0.57%	-3.84%	-3.56%
(non-eastern, mid)	9	-9.43%	-7.48%	-10.72%	-11.95%	-12.33%
(non-eastern, low)	119	-3.99%	-1.56%	-8.57%	-5.64%	-7.10%

Notes: This table displays a summary of Hukou-based utility changes by group (weighted by Hukou population) in 2005 and 2010. 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 consistency of comparisons over time.

D.3 Utility Changes in the Second Counterfactual

Table F2 shows the utility changes in our second counterfactual. When we remove the inland-favoring land supply policy and replace it with a direct transfer, the total utility of the country can increase by 2.47% in 2005 and by 4.31% in 2010. Meanwhile, with direct transfer from developed regions to underdeveloped regions, we can increase the average utility for people from both developed cities and underdeveloped cities. Compared to the first counterfactual, the advantage of this policy is that now the utility of workers from underdeveloped cities will not decrease when the inland-favoring policy is eliminated. They are better off thanks to the compensation from the direct transfer.

Table F2: **Direct Transfer Instead of Land Policy: Regional Utility**

Regions (location, development)	No. of Cities	Hukou-based Utility Changes (R/U, skill) All	(Rural, Low)	(Rural, High)	(Urban, Low)	(Urban, High)
Utility Changes in 2005						
National	225	2.47%	0.94%	4.12%	-8.89%	-8.68%
(eastern, high)	8	5.41%	-3.67%	13.78%	-17.79%	-18.12%
(eastern, mid)	28	-0.22%	3.51%	0.60%	-9.19%	-8.08%
(eastern, low)	61	1.13%	1.33%	1.96%	-8.02%	-6.93%
(non-eastern, mid)	9	1.81%	1.78%	3.62%	-7.91%	-7.24%
(non-eastern, low)	119	2.81%	6.89%	2.53%	-6.13%	-5.33%
Utility Changes in 2010						
National	225	4.31%	6.84%	9.58%	-20.57%	-20.70%
(eastern, high)	8	4.67%	5.19%	9.07%	-39.98%	-40.05%
(eastern, mid)	28	-2.51%	11.11%	7.11%	-21.60%	-19.08%
(eastern, low)	61	2.26%	9.24%	3.42%	-18.38%	-17.15%
(non-eastern, mid)	9	9.82%	23.03%	29.41%	-15.53%	-13.79%
(non-eastern, low)	119	6.56%	11.23%	11.89%	-15.22%	-14.80%

Notes: This table displays a summary of Hukou-based utility changes by group (weighted by Hukou population) in 2005 and 2010. 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 consistency of comparisons over time.

E Model with Agglomeration: Counterfactual Results

In this section, we introduce agglomeration effect in our model. We study the counterfactuals if we consider the economics of density as in Ahlfeldt et al. (2015).

E.1 Introducing Agglomeration Forces

We now introduce endogenous agglomeration forces as in Ahlfeldt et al. (2015) with slight modifications. We allow urban labor productivities for both skills to depend on production fundamentals (a^h_{ju} and a^l_{ju}) and production externalities (Υ_j). Production externalities impose structure on how the productivity of a given region is affected by the density of workers with the region,[24]

$$A^s_j = a^s_j \times (\Upsilon_j)^\gamma, \quad \Upsilon_j = \frac{H^h_j + H^l_j}{\bar{L}_j} \tag{58}$$

where $(H^h_j + H^l_j)/\bar{L}_j$ is the working population density per unit of administration land area; and γ controls its relative importance in determining the overall productivity. Since we have no feasible data and method to estimate γ, we calibrate the baseline value to be 0.07 as in Ahlfeldt et al. (2015).

E.2 With Agglomeration: Eliminating the Inland-favoring Land Policy

Table E1 shows the comparison of counterfactual results between models with and without agglomeration effect. For each outcome variable, we show the results in the baseline model in columns named "w/o" and results in the model with agglomeration in columns named "agg.". It reveals that models with agglomeration can amplify the effect of eliminating the inland-favoring land policy. In 2005, it increases national level urban output by 2.6% (compared with 2.2% in the baseline model), the urban TFP by 7.3% (compared with 6.2% in the baseline model), and the total income by 1.32% (compared with 1.10% in the baseline model). The results in 2010 show similar patterns. Tables E2, E3, and E4 show more details of the counterfactuals results. We also implement the direct transfer policy in the model with agglomeration. The agglomeration also amplify the policy effect in that case. The results are available upon request.

[24] Considering administrative zones are fixed, the changes in density are identical to changes in population.

Table E1: **With Agglomeration: Eliminating the Inland-favoring Land Policy**

Regions (location, development)	No. of Cities	Urban Output w/o	Urban Output agg.	Urban TFP w/o	Urban TFP agg.	Wage Income w/o	Wage Income agg.	Total Income w/o	Total Income agg.
Panel A: Percentage Changes in $\widehat{2005}$									
National	225	2.2%	2.6%	6.2%	7.3%	1.10%	1.32%	1.10%	1.32%
(eastern, high)	8	13.5%	14.3%	8.3%	11.6%	0.23%	0.37%	5.22%	6.04%
(eastern, mid)	28	1.0%	1.0%	-1.0%	0.0%	-0.06%	0.05%	0.20%	0.33%
(eastern, low)	61	-0.8%	-0.9%	0.0%	-1.0%	0.98%	1.11%	0.59%	0.67%
(non-eastern, mid)	9	-1.4%	-1.4%	0.0%	0.0%	0.10%	0.20%	-0.05%	0.02%
(non-eastern, low)	119	-1.9%	-1.9%	0.0%	0.0%	2.04%	2.38%	1.34%	1.59%
Panel B: Percentage Changes in $\widehat{2010}$									
National	225	2.3%	2.3%	5.1%	7.3%	1.03%	1.47%	1.04%	1.47%
(eastern, high)	8	19.1%	20.8%	10.5%	18.5%	-0.86%	-0.53%	9.14%	10.59%
(eastern, mid)	28	5.5%	6.6%	1.0%	3.0%	-0.24%	0.10%	1.42%	1.99%
(eastern, low)	61	-4.1%	-4.1%	-1.0%	-2.0%	1.35%	1.73%	0.50%	0.75%
(non-eastern, mid)	9	-13.2%	-13.9%	-9.5%	-10.4%	-1.37%	-1.26%	-3.58%	-3.60%
(non-eastern, low)	119	-7.7%	-8.0%	-4.9%	-6.8%	1.66%	2.18%	0.37%	0.73%

Notes: This table displays a summary of changes in urban output and measured TFP by group (weighted by population) in 2005 and 2010 as well as Hukou-based wage income and total income. For notation, “w/o" stands for without agglomeration, "agg." stands for with agglomeration. 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 consistency in comparisons over time.

Table E2: **With Agglomeration: 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	Urban Output / Population
Panel A: Percentage Changes in $\widehat{2005}$								
National	225	0.0%	1.5%	-3.4%	-3.4%	2.6%	-0.9%	1.3%
(eastern, high)	8	4.5%	15.0%	-21.6%	-21.6%	14.3%	0.4%	0.8%
(eastern, mid)	28	0.6%	1.1%	-6.0%	-6.0%	1.0%	0.0%	0.0%
(eastern, low)	61	-0.7%	-0.9%	-0.1%	-0.1%	-0.9%	-1.0%	-0.1%
(non-eastern, mid)	9	-0.6%	-0.4%	6.2%	6.2%	-1.4%	0.0%	-1.0%
(non-eastern, low)	119	-1.5%	-2.0%	-1.6%	-1.6%	-1.9%	-1.7%	0.1%
Panel B: Percentage Changes in $\widehat{2010}$								
National	225	0.0%	1.8%	-6.7%	-6.7%	2.3%	-1.9%	0.9%
(eastern, high)	8	11.8%	18.1%	-22.1%	-22.1%	20.8%	5.0%	3.0%
(eastern, mid)	28	3.6%	5.6%	-22.2%	-22.2%	6.6%	2.0%	1.3%
(eastern, low)	61	-3.1%	-3.0%	7.6%	7.6%	-4.1%	-1.4%	-1.1%
(non-eastern, mid)	9	-7.6%	-8.8%	25.0%	25.0%	-13.9%	0.9%	-5.9%
(non-eastern, low)	119	-4.7%	-5.9%	2.9%	2.9%	-8.0%	-3.6%	-2.5%

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 consistency in comparisons over time.

Table E3: **With Agglomeration: Removing the Inland-favoring Policy: Measured TFP**

Regions (location, development)	No. of Cities	2005 Total	2005 Fund	2005 SP	2005 LSP	2010 Total	2010 Fund	2010 SP	2010 LSP
National	225	7.3%	6.2%	0.0%	1.0%	7.3%	8.3%	-1.0%	0.0%
(eastern, high)	8	11.6%	13.9%	-5.8%	4.1%	18.5%	16.2%	-3.0%	5.1%
(eastern, mid)	28	0.0%	-1.0%	0.0%	1.0%	3.0%	2.0%	0.0%	1.0%
(eastern, low)	61	-1.0%	-1.0%	0.0%	0.0%	-2.0%	-1.0%	0.0%	-1.0%
(non-eastern, mid)	9	0.0%	1.0%	0.0%	-1.0%	-10.4%	-5.8%	0.0%	-4.9%
(non-eastern, low)	119	0.0%	0.0%	0.0%	0.0%	-6.8%	-2.0%	-2.0%	-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, 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 consistency in comparisons over time.

Table E4: **With Agglomeration: Removing the Inland-favoring Policy: Worker Incomes**

Regions (location, development)	No. of Cities	Hukou-based Income 2005	$\widehat{2005}$	Changes	2010	$\widehat{2010}$	Changes
(A) Hukou-based Average Wage Income							
National	225	14.6	14.8	1.32%	28.5	28.9	1.47%
(eastern, high)	8	26.1	26.2	0.37%	40.6	40.4	-0.53%
(eastern, mid)	28	20.8	20.8	0.05%	36.3	36.4	0.10%
(eastern, low)	61	12.9	13.0	1.11%	26.3	26.8	1.73%
(non-eastern, mid)	9	16.0	16.0	0.20%	30.4	30.0	-1.26%
(non-eastern, low)	119	12.6	12.9	2.38%	26.5	27.1	2.18%
(B) Hukou-based Average Total Income							
National	225	19.0	19.2	1.32%	36.9	37.5	1.47%
(eastern, high)	8	44.5	47.2	6.04%	84.9	93.9	10.59%
(eastern, mid)	28	28.7	28.8	0.33%	52.7	53.7	1.99%
(eastern, low)	61	16.1	16.2	0.67%	32.8	33.0	0.75%
(non-eastern, mid)	9	20.6	20.6	0.02%	40.9	39.5	-3.60%
(non-eastern, low)	119	15.4	15.7	1.59%	31.8	32.1	0.73%

Notes: This table displays a summary of Hukou-based average wage income and total income by group (weighted by Hukou population) 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 consistency in comparisons over time.