Journal of Housing Economics 33 (2016) 70–81

Contents lists available at ScienceDirect

Journal of Housing Economics

journal homepage: www.elsevier.com/locate/jhec

Housing prices raise wages: Estimating the unexpected effects of land supply regulation in China☆

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ARTICLE INFO

Article history:
Received 18 July 2015
Revised 10 July 2016
Accepted 12 July 2016
Available online 14 July 2016

JEL classification:
J30
R31
R52

Keywords:
Housing price
Wage
Construction land use quota
Land supply
China

ABSTRACT

China is currently experiencing rapid rises in labor cost. Since 2003, the central government has increased the share of land use quotas allocated to the central and western regions to support their development. As a result, the relative decline in land supply in the eastern regions has raised housing prices and consequently increased wages, damaging the competitiveness of the Chinese economy. On the basis of city-level panel data from 2001 to 2010, we used the per capita land supply as the instrument variable for housing prices and analyzed the sub-samples along the border between the inland and the eastern regions. We found that land supply policies have led to the rapid growth of housing prices and increased wages in the cities where land supply has been restricted, mainly in eastern region. This study indicates that regardless of the geographical advantages of the east region, land supply policies have had a negative impact on the efficiency and competitiveness of the Chinese economy.

1. Introduction

Accompanying the slowdown of the Chinese economy, labor costs have experienced a rapid rise, which is thought to be indicative of China losing its competitive advantage. Since the reform and opening-up in 1978, the super-high speed of economy growth and industrialization should have ascribed to the reallocation of labor forces from rural to urban areas across regions. This massive rural-urban migration made China the world's factory. However, lots of coastal cities have suffered labor shortages, and even the wages of workers and rural migrants have undergone a rapid rise since 2003 (Zhang et al., 2011). Coincidently, housing prices have experienced rapid rises in the coastal area, faster than the wage growth (See Fig. 1).

Are rising housing prices and wages the fruits of economic development, or are they the consequences of other factors, such as land use regulation? On one hand, rising wages driven by economic growth will push up housing prices through an increase of demand; on the other hand, rising housing prices that are a major cost of living in cities can also increase the nominal wage. Based on these two views, we can classify the reason for rising wages into two categories. The first is the outcome of enhanced labor productivity, which improves the welfare of workers and maintains economic growth. The other category is driven by high living costs in cities. The decreased inflow of the labor force and decreases in labor supply caused by rising living costs, such as housing prices, can lead to rising wages in cities which receive migrants. This will depress profits and cause factories to substitute labor with capital; more seriously, they may close or relocate somewhere with an abundant labor force. If rising wages are a result of land use policies, this may create the illusion of a disappearing comparative advantage in labor-intensive industries, which could lead to too early industrial upgrading and an excessive substitution of capital for labor. Therefore, it is fundamental to investigate the causes behind China's rising wages.

☆ We are thankful to the helpful comments from the two referees, as well as the seminar participants at Chinese Academy of Social Sciences, Peking University, Fudan University, Shanghai Jiaotong University, National University of Singapore, Central China University of Science and Technology, and the discussants at the International Workshop on Regional and Urban Economics (Tsinghua University, 2015). The supports of China's National Social Science Funds (13&ZD015 and 12AZD045) and National Natural Science Funds (71273289 and 71133004), and Fudan Lab for China Development Studies are greatly acknowledged.

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http://dx.doi.org/10.1016/j.jhe.2016.07.002
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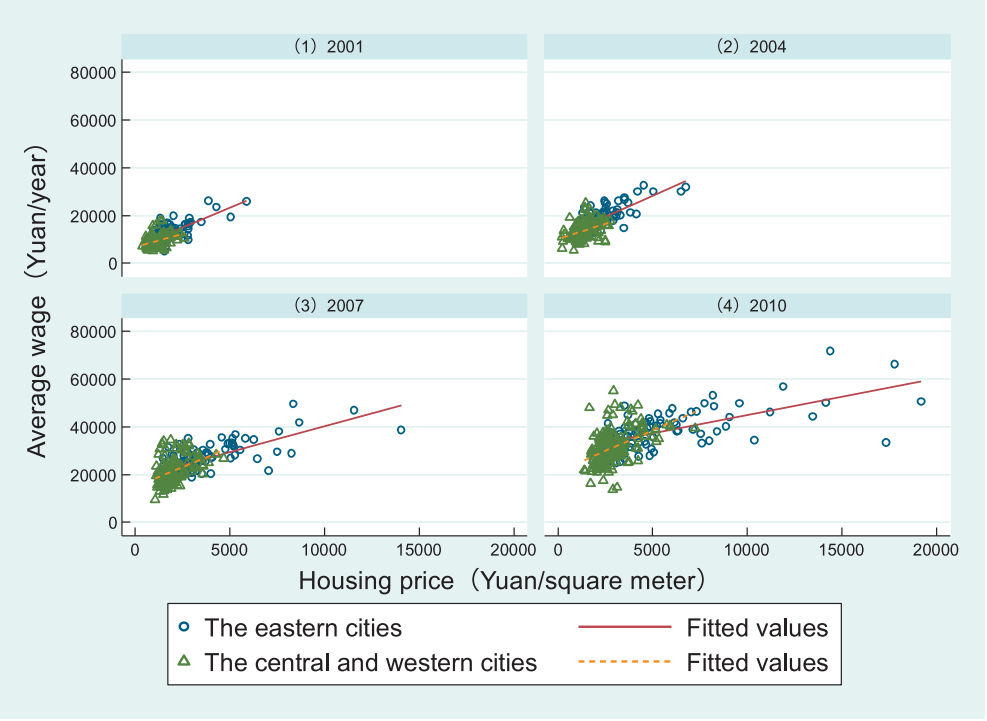

Fig. 1. Housing price and wage in the prefecture-level cities.
Source: Please refer to the fifth section of this paper.

According to the facts listed above, we argue that both the increase in housing prices and wages are not just a coincidence, but have a causal relationship behind them. Using the panel data of prefecture-level cities from 2001–2010, we have investigated how land policies have affected housing prices, which then resulted in rising wages. We find that the housing prices driven by restricting construction land use quotas in the eastern region have pushed up the wages. These results are robust in the samples near the border between the eastern and inland regions. We also find that the effect of housing prices on wages only exists in the eastern region that is receiving migrants, but also more strictly constrained by the construction land use quotas. The conclusion of our paper can be used to explain the rapid growth of wages in China, especially in the coastal region.

The remainder of the paper is organized as follows. Section 2 reviews the related literature regarding housing prices and wages. Section 4 constructs a simple theoretical model to guide the empirical analysis. Section 5 introduces the empirical model, the data and the identification methods. Section 6 reports the empirical results. Section 7 presents some robust checks. Section 8 concludes the study.

2. Literature review

Ever since 2003, along with China's policies of moving resources to the inland provinces, the TFP of firms has experienced lower growth, and resource reallocation efficiency (measured by the standard deviation of TFP) has also been undermined, especially true for firms located in inland cities (Lu and Xiang, 2016). Accompanying the decrease of the aggregate of land use quota supply since 2003, housing prices have also increased since 2003, especially in the eastern cities. Monetary policies, low interest rates, rising income and urbanization can lead to increasing housing prices (Chow and Niu, 2014; Shen, 2012; Zhang et al., 2012; Zhang, 2013). Additionally, decreases in construction land use quotas can result in higher costs of housing construction, embodied in increased housing prices. However, all explanations have ignored the interregional differences between construction land use quotas between the eastern cities and the inland cities, and do not consider the effects on the labor market.

Our paper attempts to fill this gap by constructing a spatial equilibrium model to investigate how land policy has affected housing prices, causing effects on labor supplies and wages in the labor market. Our argument holds that the relative decrease of construction landuse quotas in the cities receiving the immigration of labor has resulted in housing prices increasing, preventing the immigration of labor, consequently increasing wage rates. Similarly, CASS (2011) found that the rapid rise of land prices has depressed industrial development. Gao et al. (2012) also found that high housing prices in the eastern cities have resulted in a crowding-out effect on low value-added labor-intensive industries. Such an effect is not unique to China. Rabe and Taylor (2010) found that high living costs are behind decreasing labor supplies in Southeast England. Saks (2004) found that housing prices in cities with stricter land supply regulations experience higher growth rates, and then depress the inflow of the labor force. Unlike these studies, our paper firstly uses Chinese data to provide evidence of the spatial model based on the labor market and the housing market, and gives a reasonable explanation for the unusual rise in wages and housing costs.

Our study is also related to the literature exploring the effect of various land-use regulations. Using data of more than 100 Florida cities, Ihlanfeldt (2007) finds greater regulation restrictiveness results in the decrease of vacant land price. Similarly, Turner et al. (2014) also shows the land use regulation decreases land values substantially. But Zhou et al. (2008) gets an opposite conclusion based on a 1957 change to Chicago zoning. Secondly, there is also a large literature that focuses on the effect housing prices. Quigley and Raphael (2005) finds that the cities that have more stringent regulation of development and land use have lower price elasticity of supply and higher housing prices and rents based on

different sources of data. Saiz (2010) estimates a system of equations for housing demand and supply and concludes that regulation increases housing prices. The same conclusion can also be found in other papers, e.g., Glaeser and Gyourko (2003), Glaeser et al. (2005), Glaeser and Ward (2009), Gyourko et al. (2013). The indirect effects of land use regulation have become an ongoing topic recently. Brueckner and Sridha (2015) finds that land use regulation, which imposed via limits on a building's "floor-area ratio", would decrease population density and increase commute time naturally. Glaeser and Ward (2009) finds the regulations can boost housing prices by decreasing density. Furthermore, Turner et al. (2014) shows the large negative effects of regulation on welfare. Hsieh and Moretti (2015) provides a normative analysis of potential growth and finds that if lowering housing supply regulatory constraints in these cities like New York, San Francisco and San Jose to the level of the median city would expand their work force and increase U.S. GDP by 9.5%. Our paper contributes to these literatures by providing empirical evidence from a large developing country based on a spatial model that includes the labor market and the housing market. Using this model, we can analyze how land use regulation affects the local labor market and its competitiveness through housing market, which is an unexpected result of the land policy in China.

3. Land system in China

In this section, we briefly introduce the land system in China. Our paper focuses on the land-related issues across cities, so we mainly focus on the land policy in urban areas where all land is state-owned.

In China, the government has owned all land in urban areas, and state and collective ownership of land have co-existed in rural areas since private ownership of land ended in 1956. The land is classified as agricultural land, construction land or unused land. According to the *Land Management Law of the People's Public of China*, which was adopted in 1986 and revised in 1988 and 1998, the "agricultural land" is defined as "land used directly in agricultural production", "construction land" as "land on which buildings or other structures are built, including land used for urban and rural housing and public works", and "unused land" as "land other than agricultural land and construction land".

Given the public ownership of land in China, how much land can be transferred from agricultural land to construction land during urbanization is planned every year by a quota system. The construction land quota at provincial level is set and distributed by the central government. Under this system, the allocation of construction land quota is used as a policy tool for regional development. In the *National Master Land Use Plan (2006–2010)*, it's stated that in the Eastern region the total construction-use land is controlled, and the incremental construction-use land is controlled strictly, while in the Central region, the incremental construction-use land is increased to support the development there. In *China Land and Resources Bulletin (2001)*, its' stated that the preferential policies to use land and resources should be used to support the Western development.

In the early 1990s, nearly all land use rights were transferred through direct allocation and contracts between the government and land developers. Under that land system, land allocation was an inefficient management tool since it could not automatically respond to economic changes. Therefore, gradually, more competitive allocation procedures were introduced to establish the rights transfer process for urban land allocation based on market principles. Further reforms toward market-based land use rights and allocation began in 2002 when the Ministry of Land and Resources stipulated that the transfer of land use rights for commercial use, comprising commerce, tourism, entertainment, and real estate development, should be made through three types of auctions in the land market: the *guapai* auction, called a two-stage auction; the *paimai* auction, which is an English auction; and the sealed bid, or *zhaobiao* auction (Cai et al., 2013). In 2004, the government expanded the requirement of competitive bidding to transfer of land for industrial uses. In 2006, the State Council stipulated that the transfer prices were to be above a minimum price set by the government. Therefore, the share of the total construction land area allocated through public bidding increased from 59% of total supplied land in 2001 to nearly 80% in 2006 and 2007 (Word Bank, 2014).

More importantly and closely related to the study in this paper, since 2003, the central government has released stricter regulations on the quantity of aggregate land supply, especially in the eastern cities. The central government has given more construction land-use quotas to the inland cities for the sake of their economic development. From Fig. 2, we can see that the share of land use quotas in the inland cities have increased since 2003. But the eastern cities are still experiencing an inflow of migrants (Lu and Xia, 2016), which means the demand of land is stronger compared to their supply in the East. However, the marketization reform in land system has only strengthened the role of market auction given the land supply within a region. Even though the prices of various kinds of construction land are more expensive in the East, especially in the large cities, the local governments are prohibited from trading construction land use quotas across provinces.

4. A simple theoretical model

We first construct a spatial equilibrium model to explore the relationship between land policy, housing price, labor mobility and wage, following the work of Roback (1982) and Moretti (2011).

4.1. Consumer

Suppose the city has a competitive labor market and only produces a good that can be transported between cities at no cost. The price of the product is the same across cities, so we have normalized it to 1 for simplicity. For the sake of exploring the effects of land policy, we have assumed the labor and firms are absolutely mobile across cities, and do not take into consideration policies that restrict the mobility of labor, such that the *Household Registration System (hukou)* in China. Additionally, we assume the elasticity of the labor supply is zero, which means that the aggregate labor supply is equal to the population in the city.

Suppose the utility function of a labor is as follows:

$$U = x^{\alpha} y^{\beta}$$

where$x$ is the non-tradable good, such as the housing in our model. The housing price is R. In this model, we do not distinguish the housing price and rent. y is a tradable product. For simplicity, we have assumed the income of the consumer is only the wage, W. Then the problem the consumer faces is as follows:

$$\max U = x^{\alpha} y^{\beta}$$
$$s.t. y + Rx \leq W$$

Then we get the indirect utility function:

$$\frac{\ln U - \ln C}{(\alpha+\beta)} = \ln W - \frac{\alpha}{(\alpha+\beta)} \ln R$$

where $C = \frac{\alpha^{\alpha}\beta^{\beta}}{(\alpha+\beta)^{\alpha+\beta}}$ is a constant value, $\theta \equiv \frac{\alpha}{(\alpha+\beta)} < 1$ is the share of income spent on housing. We have changed the notation for the sake of this analysis. $w = \ln W$ is the nominal wage, $r = \ln R$ is the nominal housing price, $u = \frac{\ln U - \ln C}{(\alpha+\beta)}$ is the monotonous change of the utility level U, then:

$$u = w - \theta r \tag{1}$$

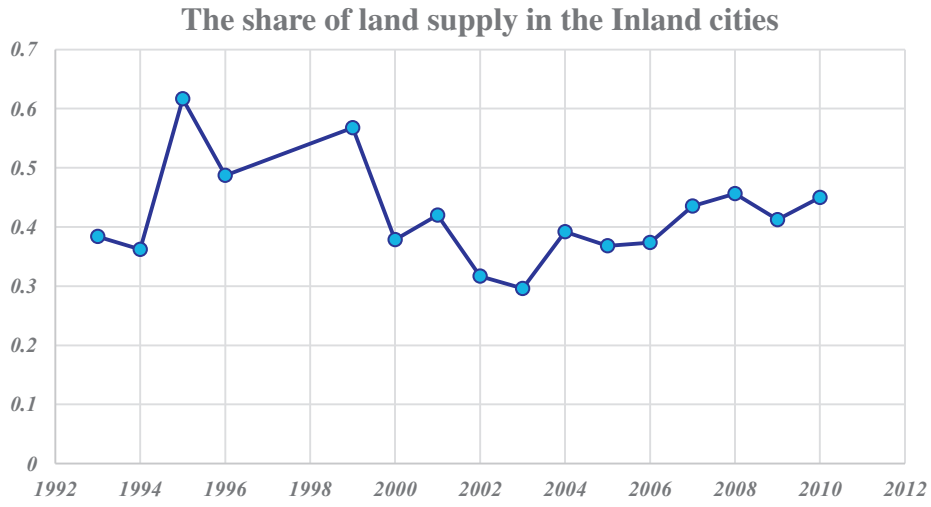

Fig. 2. The share of land supply in the Inland cities.
Source: The Yearbooks of Land (1995, 1996 and 1997) and the Yearbooks of National Land and Resource (2000, and 2001). The data for 1997 and 1998 is unavailable.

In the context of complete mobility across cities, consumers get the same utility levels across cities; otherwise, they have the incentive to move in order to get a higher utility. Equilibrium situations where no one has the incentive to move are known as spatial equilibrium. According to Eq. (1), we can find that the wage increase will be accompanied by rising housing prices, which means that higher incomes in cities will compensate through higher living costs to reach spatial equilibrium (Glaeser and Gottlieb, 2008; Roback, 1982).

We can obtain the relationship between housing prices and wages from Eq. (1), but we can't demonstrate how the transportation of labor works to obtain spatial equilibrium. Following Moretti (2011), we have introduced a random term that represents worker's idiosyncratic preference for the city, and then found the population distribution across cities and used that to demonstrate how land policies affect population distribution to achieve a new spatial equilibrium.

Assume the indirect utility function of worker i in city c is

$$u_{ic} = w_c - \theta r_c + e_{ic}$$

Where e_{ic} represents worker i's idiosyncratic preference for city c. Suppose there are two cities: City a, and City b; then worker i's idiosyncratic relative preference for the city is from a uniform distribution, $e_{ia} - e_{ib} \sim U[-s, s]$; when s becomes larger, the preference for location is stronger.

In equilibrium, the utility level in City a and City b are the same, $U_{ia} = U_{ib}$; then we find that $e_{ia} - e_{ib} \geq (w_b - \theta r_b) - (w_a - \theta r_a)$; the population distributions between the two cities are as follows:

$$\frac{n_a}{n} = \frac{s - [(w_b - \theta r_b) - (w_a - \theta r_a)]}{2s};$$
$$\frac{n_b}{n} = \frac{s + [(w_b - \theta r_b) - (w_a - \theta r_a)]}{2s}$$

where n_c is the log population of city$c$ $(c = a, b)$,$n = n_a + n_b$; then we get:

$$w_b = w_a + (\theta r_b - \theta r_a) + s\frac{n_b - n_a}{n} \tag{2}$$

4.2. Firms

The production function of firm j in city$c$ $(c = a, b)$ is:

$$Y_{jc} = AN_{jc}^{\alpha}K_{jc}^{\beta}F^{1-\alpha-\beta}; \alpha + \beta < 1 \tag{3}$$

where A is the total factor productivity and is assumed to be the same across cities, F denotes the fixed investment, introducing it just to allow the production function to exhibit constant return to scale, then the factor demand at the firm level can be aggregated to the city level (Diamond, 2012; Kline and Moretti, 2014)

In addition, assume the capital is totally elastic, and the interest rate is I. Solving the F.O.C, then we get:

$$w_c = \frac{\alpha + \beta - 1}{1 - \beta}n_c + B, c = a, b \tag{4}$$

where $B \equiv \frac{1-\alpha-\beta}{1-\beta}f + \frac{1}{1-\beta}a - \frac{\beta}{1-\beta}i + \ln\alpha + \frac{\beta}{1-\beta}\ln\beta$; $f \equiv \ln F$; $a \equiv \ln A$; $i \equiv \ln I$.

4.3. Housing market

Suppose every consumer consumes one unit of housing, we then find the aggregate housing demand:

$$r_b = \frac{1}{\theta}(w_b - w_a) + r_a - \frac{s}{\theta}\frac{n_b - n_a}{n} \tag{5}$$

And we assume the housing supply is as follows:

$$r_c = \rho_c n_c;\ c = a, b \tag{6}$$

where $r_c = \rho_c n_c; c = a, b$ (ρ_a, ρ_b)are the supply elasticities in City a and City b. The larger$\rho_c, c = a, b$ is, the smaller the supply elasticity. Housing supply elasticity is influenced by two factors: the first is cities' geographic conditions; the other is the land policy or land use regulation across the cities (Diamond, 2012; Gyourko et al., 2008; Saiz, 2010). Although geographic conditions are substantial factors that influence the housing supply, housing price, as well as productivity and wage, such conditions cannot change in a short time, so we have not considered it in our theoretical model, but will be controlled in the empirical model. On the contrary, land policies or land-use regulations can change a lot and have variations both across time and across cities, so this becomes the focus of our research.

4.4. Equilibrium

For simplicity, we denote $\lambda_c \equiv n\theta\rho_c(1-\beta)+n(\alpha+\beta-1)+s(1-\beta)$, $(c = a, b)$.

According to Eqs. (2), (4), (6), we get the equilibrium as follows:

$$n_c = \left(1 - \frac{\lambda_c}{\lambda_b + \lambda_a}\right)n$$

$$w_c = -\frac{1-\alpha-\beta}{1-\beta}\left(1-\frac{\lambda_c}{\lambda_b+\lambda_a}\right)n + C \tag{7}$$

$$r_c = \rho_c\left(1-\frac{\lambda_c}{\lambda_b+\lambda_a}\right)n$$

4.5. Comparative static analysis

Imagine such a situation in which housing supply elasticity in City b decreases (ρ_b increases in the model). Here we study how this change would affect housing prices, wages, and population in the cities. According to (7):

$$\begin{aligned}
\frac{\partial r_b}{\partial \rho_b} &= \frac{\lambda_a}{(\lambda_b+\lambda_a)^2}n[\lambda_a + n(1-\alpha-\beta)+s(1-\beta)] > 0;\\
\frac{\partial r_a}{\partial \rho_b} &= \frac{\lambda_a}{(\lambda_b+\lambda_a)^2}\rho_a\theta n^2(1-\beta) > 0 \qquad (8)\\
\frac{\partial r_b}{\partial \rho_b} - \frac{\partial r_a}{\partial \rho_b} &= \frac{\lambda_a}{(\lambda_b+\lambda_a)^2}[2n(1-\alpha-\beta)+2s(1-\beta)] > 0
\end{aligned}$$

The housing prices in City a and City b both rise to accompany the increase of ρ_b, and the housing prices in City b will rise higher than those in City a.

Analogically, we also found the effects on wages:

$$\begin{aligned}
\frac{\partial w_b}{\partial \rho_b} &= \frac{1-\alpha-\beta}{1-\beta}\frac{\lambda_a}{(\lambda_b+\lambda_a)^2}n^2\theta(1-\beta) > 0;\\
\frac{\partial w_a}{\partial \rho_b} &= -\frac{1-\alpha-\beta}{1-\beta}\frac{\lambda_a}{(\lambda_b+\lambda_a)^2}n^2\theta(1-\beta) < 0 \qquad (9)
\end{aligned}$$

If the housing supply elasticity in City b decreases (ρ_b increases), housing prices increases, and laborers move back to City a. This resulted in a decrease in the labor supply and an increase in wages in City b. However, the labor supply increases and wages decrease in City a.

According to (8) and (9), we establish the following hypothesis to be tested in the empirical analyses:

The decrease in housing supply elasticity in City b results in the increase of housing prices there, and thus increasing the wages in City b.[1]

5. Empirical model, data and identification methods

5.1. Empirical model and data

Our empirical model is intended to investigate the effects of housing prices on wages by estimating the regression equation as follows:

$$Ln\ wage_{it} = \alpha + \beta \cdot Ln\ housing\ price_{it} + \gamma X_{it} + \varepsilon_{it}$$

$Ln\,wage_{it}$ and $Ln\,housing\,price_{it}$ indicate the wages and housing prices of a prefecture-level city i in year t. Our data are from the 286 prefecture-level cities in China between 2001 and 2010. The average wage $wage_{it}$ is calculated using the data of "total wage of workers" and "total number of workers" in the *China City Statistical Yearbook (2001–2010)*. Using the data for "housing sale income" and "housing sale quantity" in the *China Statistical Yearbook for Regional Economy (2001–2010)*, we calculated the housing price per square meter, $housing\,price_{it}$. In China, we do not have panel data for housing rents, but based on the assumption that housing prices and rents both reflect economic fundamentals, the housing prices and rents highly correlated. Fang et al. (2016) finds enormous housing price appreciation during 2003–2013, accompanied by equally impressive growth in household income, except in a few first-tier cities. Even if we cannot exclude the possibility that housing prices may have bubble in some cities sometime in the decade, the bubble means the demand had grown too fast. The IV we use for housing price, per capita land supply, is from the supply side, which means the housing prices in the second stage estimation are predicted using land supply information. Thus the effects of "bubble", even if it existed somewhere sometime, can be partialled away in our empirical model. Our interest lies in the parameter β, which measures the effect of housing price on wages. After partialling out other confounding factors that capture the city's labor productivity, such as city GDP per capita, then we can say that the effect of housing prices on wages has deviated from labor productivity, and will endanger economic competitiveness.

The inclusion of control variables X_{it} is meant to reduce missing variable bias. All the data regarding X_{it} are from the *China City Statistical Yearbook (2001–2010)*. We only used data from municipal districts to reduce measurement errors.[2] We contained the four control variables: (1) Labor productivity, measured by GDP per capita. The housing prices and wages mutually depend on the GDP per capita. The cities that have higher labor productivity also have higher housing prices and wages. The effect of housing prices on wages can be consistently estimated by conditioning on the GDP per capita. (2) Employment density, measured by the numbers of workers in the manufacturing and service sectors, per square kilometer. We intend to control for the population density, but most cities' population data in the yearbook do not include migrants without local *hukou*, so we used employment density instead. On one hand, employment density causes an increase in labor productivity; on the other hand, higher employment density means a greater labor supply in a certain area and might decrease wages. Additionally, high employment density means high demand for housing and results in high housing prices; therefore we included employment density to capture these effects. (3) Industry structure, measured by a ratio of service to manufacture production values. Most Chinese cities depend on the manufacturing sector to absorb a majority of migrants; a high industry structure means there is lower capacity to absorb these migrants, resulting in a lower wage level. (4) Investment, measured by the share of the fixed investment value in GDP. This investment will create jobs to increase demand for workers and then increase the wage levels in the city.

Additionally, we also controlled the city infrastructure and public service conditions to capture the amenity of the city. On one hand, amenity may increase workers' wages by promoting productivity; on the other hand, high amenity may attract workers to stay in these cities to enjoy a higher quality of life, even at a lower wage level. Therefore, the net effect depends on which effect plays a major role. These variables include: (5) Infrastructure, measured by road area per capita; (6) Education, measured by the numbers of middle school teachers per capita;[3] (7) Traffic conditions, measured by the numbers of public buses; (8) Environmental conditions, measured by the area of green land per capita; (9) Medical and health conditions, measured by the numbers of hospital beds per capita. Table 1 reports the statistical summary of all these variables.

Obviously, it is impossible to control all variables to capture the factors that both affect housing prices and wages, especially the unobservable factors. Therefore, we have included the interaction

[1] In the theoretical model, the housing prices in City a and *City b* both rise to accompany the decrease of housing supply elasticity of *City b*. But we only test whether the housing prices in *City b* would rise to accompany the decrease of housing supply elasticity of *City b*, but not the externality of housing supply elasticity in *City b*.

[2] China's cities govern rural areas. In the statistics, municipal districts are close to urban areas.

[3] There are no panel data regarding education years per capita at city level.

Table 1
Statistical summary of variables.

Variable	N	Mean	sd	min	max
Wage(unit: Yuan)	2683	20,066	9348	1970	71,924
hp(unit: Yuan / m^2)	2683	2197	1607	217.4	19,170
GDP per capita(unit: Yuan)	2683	26,658	21,427	1226	249,040
Invest(unit: Yuan per 10,000 GDP)	2683	5282	2386	521.1	21,475[a]
Industrystructure	2683	0.941	0.527	0.0879	5.040
Empdensity (unit: number/km2)	2683	202.4	244.0	1.647	2168
Bus per capita(unit: number per capita)	2683	0.000633	0.000658	3.17e-05	0.0115
Teacher per capita(unit: number per capita)	2683	0.00420	0.00100	0.00147	0.0100
Road per capita(unit: m2 per capita)	2683	8.168	5.628	0.0200	85.20
Green per capita(unit: m^2 per capita)	2683	0.00321	0.00541	2.31e-05	0.118
Hospital per capita(unit: m^2 per capita)	2683	0.00506	0.00223	0.000337	0.0254

[a] There are 115 samples that have larger fixed investment values than GDP. Among them, 73 samples are in the 2008, 2009 and 2010, the crisis years. If we drop these 115 samples, the results are almost the same as those in Table 3.

term of the province dummies and year dummies to control for time-varying provincial fixed effect.

5.2. Endogeneity

Even though we have controlled for the province and the time fixed effects, there are still some unobservable factors that may result in an inconsistent estimation of β. For example, the wages and housing prices are the outcomes of the local economic development. The wages and housing prices are both high in the developed cities and cause an upward bias of β. Besides, there may exist simultaneity problem. On one hand, the increasing wages will increase the demand of housing through the income effect; on the other hand, the rise of housing prices, which compose a substantial portion of living costs in the cities, must depress the agglomeration of labor (or the reduce of potential immigration), resulting in a decrease of labor supply and an increase of wages. Therefore, we have tried to use instrument variables to avoid the endogeneity problems caused by the omitted variable bias and simultaneity.

A good instrument variable must affect the wages only through the endogenous variable (housing prices, in our paper). We think 1 year lagged land supply that is controlled by the central government is a good instrument variable for housing prices. Land is the important factor in the housing market; its price is a substantial part of the housing costs (CASS, 2011). Consequently, land supply directly affects housing prices in China (Chen and Yang, 2013), the rapid increase in land prices is the indicator of housing prices. The concern is that the instrument variable may directly affect wages or through other mechanisms other than housing prices. For example, the land supply will affect wages through economic growth. But such a possibility would be removed by controlling the per capita GDP, investment, industry structure, etc. Other potential unobservables can be largely controlled for by the interaction term of province and year dummies.[4]

Because of strict land use regulations and farmland protection systems under the principle of public land ownership, the central government and province-level governments have decrees regarding the quantity and use of land supplies at the city level. The decrees claim that the Ministry of Land and Resources draws a plan for land supply according to suggestions given by the provinces, autonomous regions, and municipalities, and then submit those suggestions to the State Council. The construction land quota is the actual quantity that is used after the quota established in the land use plan has been released. Since part of the land supply is the redevelopment transformation of used construction land, so the quantity of land supply could be partially determined by housing prices. However, the total land supply is more determined by the construction land quota during the process of China's rapid urbanization. Pitifully, we do not have city-level construction land quota, but have this data at provincial level after 2003. In Fig. 3, we have compared the total quantity of construction land quotas that were transformed from cultivated lands and the total land supply at provincial level, and find they have similar spatial distributions across the eastern and inland regions. Thus, we are more confident that the city-level land supply is largely determined by the construction land quota the cities have. Considering the possibility that the land supply may also respond to the housing prices, and the time lag of the effects of land supply on housing prices, we will use 1 year lag of land supply per capita as the instrument variable for housing prices. To take advantage of the exogeneity of the construction land quota, we will also construct an alternative IV that is the provincial-level land use quota times the share of land supply a city has in the province it locates, which is named as "predicted land quota".

6. Estimation results and East-Inland heterogeneity

6.1. Evidence from the 286 prefecture-level cities

In Table 2, we presented the first-stage regression of the IV regressions to test the validity of the IV. We have found that the 1 year lagged land supply per capita had a significant negative effect on housing prices, which means that the lower the previous year's land supply per capita, the higher the housing prices are. Also reached this conclusion in Chen and Yang (2013). The coefficient of land supply areas per capita in the eastern cities is −0.00472, which is only slightly smaller than in the inland cities, −0.00545. There are high population densities and high building plot ratios in the eastern cities, so it is reasonable that land supply would have a smaller effect on housing prices. After controlling the variables that capture the city characteristics, we found that the F values were 36.009, 21.293, and 12.343, respectively, in the whole sample, East and Inland. A similar effect on housing price can be found when we use "predicted land quota" as the IV in column 4.

In Table 3, we reported both the OLS and the two-stage instrument variable regressions. In column 2, we can see the coefficient is 0.519, significant at the 1% level, larger than the OLS coefficient in column 1. This means that 1 percentage increase of housing prices drives up wages by 0.519 percentage after controlling other factors. Is the housing prices an important factor contributing to the wage increase? According to the summary statistics, the standard deviations of ln(housing price) is 0.5465, and the standard deviation of ln(wage) is 0.4664, so the contribution of

[4] If we regress both land supply and wage on housing prices and get the residuals, the correlation between the two regression residuals is 0.1620, showing a weak correlation between land supply and wage directly.

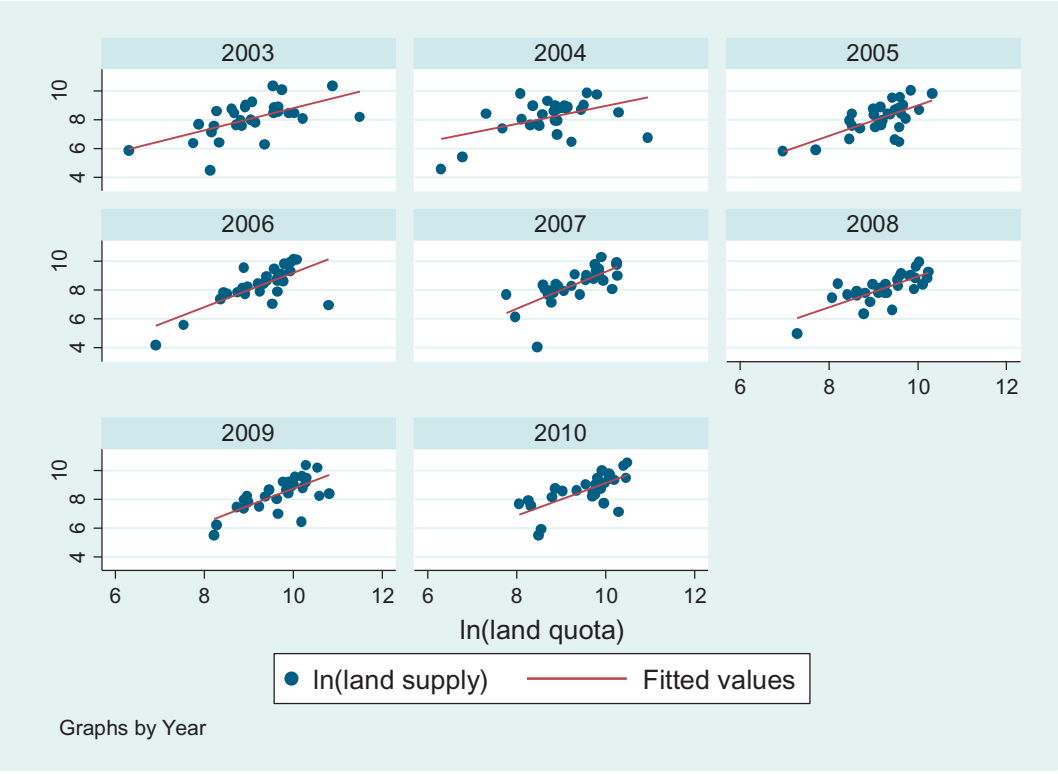

Fig. 3. The correlation between the land supply and land quota.
Data source: *China Land and Resource Statistical Yearbook (2003–2010).*

Table 2
Land supply and housing prices: the first-stage regression results.

lnhp	IV1			IV2
	Whole sample	East	Inland	Whole sample
land_percapita	−0.00504***	−0.00472***	−0.00545***	−0.00560***
	(0.000840)	(0.00102)	(0.00155)	(0.000885)
lngdp_percapita	0.334***	0.386***	0.305***	0.361***
	(0.0190)	(0.0314)	(0.0233)	(0.0205)
lninvest	0.0127	−0.0595**	0.0735***	0.0132
	(0.0155)	(0.0250)	(0.0175)	(0.0182)
lnindustrystructure	0.210***	0.222***	0.172***	0.230***
	(0.0120)	(0.0205)	(0.0144)	(0.0132)
lnempdensity	0.0312***	0.000214	0.0501***	0.0380***
	(0.00670)	(0.0117)	(0.00780)	(0.00735)
lnroad_percapita	−0.0214	0.0737***	−0.0671***	−0.0144
	(0.0157)	(0.0258)	(0.0170)	(0.0183)
lnbus_percapita	0.136***	0.160***	0.0943***	0.130***
	(0.0150)	(0.0250)	(0.0141)	(0.0185)
lnteacher_percapita	−0.0919***	−0.0770	−0.121***	−0.0876**
	(0.0314)	(0.0572)	(0.0337)	(0.0354)
lngreen_percapita	−0.0190*	0.0301	−0.0311***	−0.0301**
	(0.01000)	(0.0208)	(0.0101)	(0.0119)
lnhospital_percapita	−0.0849***	−0.173***	−0.0348*	−0.107***
	(0.0165)	(0.0307)	(0.0179)	(0.0201)
_cons	3.886***	4.242***	3.907***	3.612***
	(0.335)	(0.574)	(0.357)	(0.374)
IV F-Stat	36.009	21.293	12.343	22.681
N	2683	959	1724	1895
adj. R^2	0.825	0.855	0.762	0.814

Note: Standard errors in parentheses
* $p < 0.10$
** $p < 0.05$
*** $p < 0.01$

Table 3
Housing prices and wages: the second-stage regression results.

lnwage	OLS	IV1			IV2
	Whole sample	Whole sample	East	Inland	Whole sample
lnhp	0.134***	0.519***	0.935***	−0.0343	0.295**
	(0.0150)	(0.124)	(0.203)	(0.136)	(0.120)
lngdp_percapita	0.186***	0.0603	−0.140*	0.249***	0.135***
	(0.0115)	(0.0428)	(0.0811)	(0.0431)	(0.0447)
lninvest	0.0166*	0.0154	0.0564*	0.0416***	0.0119
	(0.00956)	(0.0106)	(0.0303)	(0.0151)	(0.0117)
lnindustrystructure	−0.00611	−0.0847***	−0.168***	0.0176	−0.0395
	(0.00829)	(0.0272)	(0.0489)	(0.0245)	(0.0290)
lnempdensity	−0.0164***	−0.0296***	−0.0429***	0.00328	−0.0196**
	(0.00470)	(0.00662)	(0.0103)	(0.0103)	(0.00776)
lnroad_percapita	−0.0285***	−0.0162	−0.0691***	−0.0469***	−0.0283**
	(0.00855)	(0.0100)	(0.0255)	(0.0154)	(0.0114)
lnbus_percapita	0.0271***	−0.0256	−0.0935**	0.0356**	0.00223
	(0.00735)	(0.0188)	(0.0394)	(0.0156)	(0.0189)
lnteacher_percapita	0.00338	0.0423*	0.0136	0.00726	0.00308
	(0.0194)	(0.0245)	(0.0517)	(0.0285)	(0.0246)
lngreen_percapita	0.00768	0.0152**	0.00478	−0.00481	0.0125
	(0.00631)	(0.00710)	(0.0183)	(0.00868)	(0.00879)
lnhospital_percapita	0.0177	0.0523***	0.181***	−0.00329	0.0381*
	(0.0120)	(0.0169)	(0.0459)	(0.0163)	(0.0199)
_cons	6.948***	5.459***	4.493***	7.414***	6.585***
	(0.183)	(0.503)	(1.029)	(0.573)	(0.485)
N	2683	2683	959	1724	1816
adj. R^2	0.895	0.859	0.757	0.875	0.825

Note: Standard errors in parentheses
* $p < 0.10$
** $p < 0.05$
*** $p < 0.01$

housing price is $(0.5465 \times 0.519)/0.4664 = 0.6081$. Similarly, the contribution of GDP per capita is $(0.7535 \times 0.0603)/0.4664 = 0.0974$, and the contribution of investment is 0.0146. Therefore, the economic significance of the housing price factor is very remarkable.

Since the East is the region receiving migrants, and restricted by the land quota system more seriously, we hypothesize that the housing price-wage causal relationship mainly exists in the Eastern sample. We divided the sample into two parts and the regression results are reported in columns 3 and 4. In column 3, we find the coefficient of β in the eastern cities sample is 0.935, significant at the 1% level, but in the inland cities it is -0.0343 and insignificant. Column 5 reports the estimation result using the 1 year lag of the predicted land quota as the IV, which is the provincial-level land use quota times the share of land supply a city has in the province it locates. The coefficient of housing price is still significantly positive. But we won't use the second IV at the expense of losing 2 years' samples later on.

Additionally, we also found that the per capita GDP has a positive effect on wages. Please notice that after controlling for per capita GDP, housing prices still raise wages, especially in the East. This means the land supply restriction has led wage to deviate from productivity, thus harming competitiveness, especially in the East.

Additionally, *lnindustrystructure* has a negative coefficient. During the period of our study, most Chinese cities depend on the manufacturing sector to absorb a majority of migrants. A high service share means there is lower capacity to absorb the migrants, resulting in a lower wage level. The coefficient of *lnempdensity* is also negative. On one hand, employment density causes an increase in labor productivity; on the other hand, higher employment density means that a greater labor supply in a certain area can decrease wages. If we do not control for *GDP per capita*, the coefficient of *lnempdensity* becomes positive. We do not report this result to save space. *Lnroad_capita* captures the infrastructure of the city. On one hand, such amenity may increase workers' wages by promoting productivity; on the other hand, high amenity may attract workers to stay in these cities to enjoy a higher quality of life, even at a lower wage level. Therefore, the net effect depends on which effect plays a major role. We have controlled for *GDP per capita* to measure productivity, and other variables to capture the amenity of city, so the negative coefficient of *Lnroad_capita* may only reflect the net effect that people give up some income to enjoy the infrastructure of a city (Table 3).

6.2. Evidence from East-Inland border sample

The results presented in the last section can still be inconsistent if the IV has been associated with unobservable factors that may directly affect wages. To avoid such a possibility, we only used a sample near the border between eastern and inland regions (listed in Fig. 4) to investigate the effect of housing prices on wages. The cities near the border have similar geographic locations, weather conditions, and other unobservable factors. This estimation can largely remove the association between the instrument variable and unobservable factors, which would render a more consistent estimation of β. Not all eastern cities have had lower construction land use quotas since 2003. As old industrial bases, the Liaoning province has not reduced construction land use quotas since 2003. Hebei province is the only out-migration province in the eastern region. We have listed the construction land use quota changes in the eastern cities from 2001–2010. In Table 4, we found that the land quota in the eastern cities near border have been significantly reduced since 2003, while the construction land use quotas in the cities of the Liaoning and Hebei provinces near the border have not decreased at all, but have instead increased. We can ascertain that the central government has given the Liaoning and Hebei provinces the privilege of construction land use quotas, so we have not included the two provinces and their neighbors in Table 5.

The IV result in Columns 2 of Table 5 shows the coefficient of housing price is 0.619 which is larger than that 0.0824 in column 1.

Table 4
Construction land use quotas in the eastern cities near the border.

	2001–2003	2004–2010	T value
Eastern cities near border	0.791	0.728	1.8241
Eastern cities near border (not including Liaoning, Hebei province)	0.612	0.534	1.6766
Liaoning, Hebei Province	0.178	0.194	–0.8923

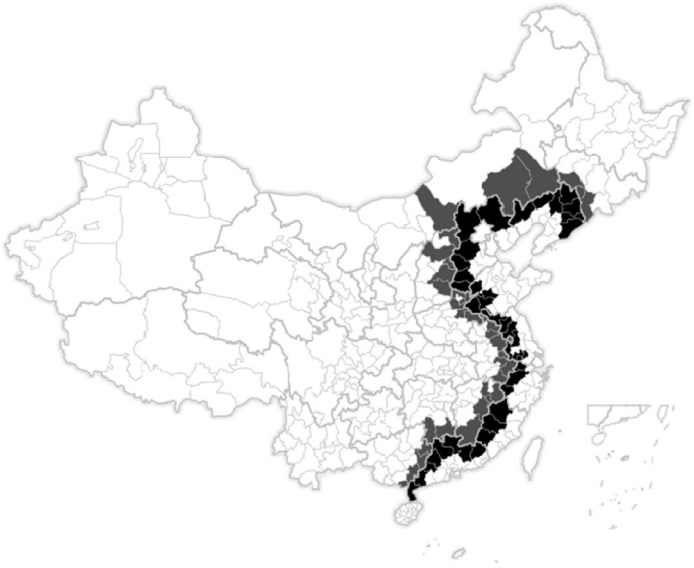

Fig. 4. City Samples near the East-Inland border.

Table 5
Housing prices and wages: border samples.

lnwage	OLS	IV		
	Whole Sample	Whole Sample	East	Inland
lnhp	0.0824**	0.619***	0.390***	1.530
	(0.0376)	(0.233)	(0.139)	(1.771)
_cons	8.188***	6.767***	8.021***	1.226
	(0.466)	(0.824)	(0.646)	(9.524)
IV F-Stat.		8.2956	15.4225	0.7175
N	456	456	237	219
adj. R^2	0.922	0.872	0.906	0.569

Note: Standard errors are in the parentheses. *** 1%, ** 5%. Other control variables, the province -year fixed effect have been controlled but are not listed in the table.

Table 6
Robustness checks: using alternative IV.

lnwage	IV: The ratio of land supply to city area		
	Whole sample	East	Inland
lnhp	0.669***	0.626***	0.155
	(0.199)	(0.207)	(0.299)
_cons	4.880***	5.954***	6.686***
	(0.795)	(1.028)	(1.176)
Control variables	Y	Y	Y
Province × time dummy	Y	Y	Y
IV F-Stat	11.8811	16.1313	5.1112
N	2682	959	1723
adj. R^2	0.825	0.854	0.880

Note: Standard errors are in the parentheses. *** 1%. Other control variables and the province -year fixed effect have been controlled but are not listed in the table.

The magnitude difference between them suggests the necessity of using the IV identification strategy again. In Columns 3 and 4, the coefficient was 0.39 in the sample of eastern cities near the border, significant at 1% level, but was not significant in the sample of the inland cities near the border.

7. Robustness checks

7.1. Results using other instrument variable

In Section 6, we used the previous year's land supply quota as the instrument variable for the current year's housing prices. In Table 6, we used another instrument variable to test the robustness of the previous results. We used the ratio of a city's construction land supply to its built-up area to instrument housing prices. The coefficient in the fourth column of Table 6 is 0.669, significant at 1% level. The coefficient in the second column is 0.626, also significant at 1%, and the one in column 3 is 0.155, not significant even at the 15% level. The comparison between column 2 and 3 also suggest the effect of housing prices on wages only exists in the eastern cities.

Besides, we also used the relative wages measured by the ratio of a city's wage and the whole country's wage as the dependent variable, the relative land supply measured by the ratio of a city's construction land supply per capita and the whole country's construction land supply as the instrument variables for housing prices. We get similar results as before.

Additionally, some potential consumers may find that construction land use quotas decreased in some cities and have a rational expectation for increase in the next year's housing prices, so they should buy housing in the current year. We used the current year's land supply per capita as the instrument variable for the current year's housing prices, and get the similar results. We don't report these results to save space.

Table 7
Other robustness checks (IV = 1 year lagged land supply per capita).

lnwage	(1) Controlling pop. growth			(2) Excl. superstar cities			(3) Excl. outliters		
	Whole sample	East	Inland	Whole sample	East	Inland	Whole sample	East	Inland
lnhp	0.496***	0.885***	−0.0857	0.533***	1.010***	−0.0343	0.591***	0.952***	−0.0274
	(0.119)	(0.204)	(0.161)	(0.143)	(0.287)	(0.161)	(0.150)	(0.228)	(0.208)
popgrowth	−0.0255***	−0.0477***	−0.0240						
	(0.00773)	(0.0142)	(0.0153)						
_cons	5.455***	4.627***	7.471***	5.545***	4.989***	7.414***	5.293***	4.632***	7.435***
	(0.500)	(1.048)	(0.653)	(0.514)	(1.098)	(0.656)	(0.580)	(1.070)	(0.838)
Control variables	Y	Y	Y	Y	Y	Y	Y	Y	Y
Province × time dummy	Y	Y	Y	Y	Y	Y	Y	Y	Y
IV F-Stat	34.3854	19.3325	18.9274	27.7934	12.7289	18.5014	24.0424	15.0338	10.89
N	2514	947	1567	2645	921	1724	2656	945	1711
adj. R^2	0.862	0.778	0.869	0.853	0.716	0.875	0.863	0.789	0.884

Note: Standard errors are in the parentheses. *** 1%. Other control variables and the province -year fixed effect have been controlled but are not listed in the table.

7.2. Other robustness checks

The central government's decisions may actually follow somewhat the market logic which means that the policymakers may distribute the land quotas in favor of cities that are growing and have more need for land. So we exclude this possibility by controlling for the population growth in the previous 5 years. In the first column of Table 7, the coefficients of housing prices, 0.496, is almost unchanged comparing to the result in the baseline results in Table 3. The results in column 2 and 3 also suggest that the effect of housing prices on wages only exists in the eastern cities.

The potential outliers in the empirical analysis, especially the "superstar cities", may also confound our baseline results. So we remove the samples of Beijing, Shanghai, Shenzhen and Guangzhou in the middle three columns, the coefficient of housing prices is 0.533 (0.519 while including the four city samples), so we are confident that the result is robust. The results in columns 5 and 6 are also robust. Actually, the previous results for the East-Inland border samples also exclude the largest cities. Besides, we calculate the ratio of housing price to wage, and exclude the samples that hold the largest or smallest 0.5% of housing price-wage ratio. The coefficient in column 7 is 0.591 which suggests the robustness of our results again.

In a word, the results in Table 7 again show that the housing prices would push up the wages, and such effect only exists in the eastern cities.

7.3. Other confounding factors

According to the baseline results and robust checks in Section 6.1, we are inclined to argue that the reduction in construction land use quotas in the eastern cities has caused increasing housing prices, and then pushed up wages to compensate for higher costs of living in the cities. We still need to partial out other factors that may have similar changes as construction land use quotas, although we have controlled several variables and used the instrument variable method.

First, other productivity factors. If we suppose the eastern cities have experienced a faster rate of productivity growth than the inland cities, we can also find that the wages in the eastern cities have risen faster, leading to housing prices growing faster again through the income effect. Such an effect will challenge our argument. Actually, we have controlled GDP per capita as a measurement of productivity. Even if there are other productivity factors not captured by GDP per capita, we can compare the trend of GDP per capita in the East and the Inland to exclude the possibility that the Eastern cities have seen a higher productivity growth that has driven a faster growth of both housing prices and wages. We have used production per worker in the manufacturing and service sectors to proxy productivity and calculated a productivity ratio of the Eastern to the Inland. In Fig. 5, we see that the ratio has decreased since 2003, so unobserved productivity can't have driven a faster growth both in housing prices and wages in the East, especially after we have controlled the GDP per capita in all our regressions.

Table 8
Robustness check: adding minimum wage.

lnwage	Whole sample	Eastern cities	Inland cities
lnhp	0.547***	1.083***	−0.0942
	(0.145)	(0.288)	(0.173)
lnminiwage	−0.232	−0.952***	0.554***
	(0.159)	(0.326)	(0.133)
_cons	6.446***	8.781***	4.941***
	(0.319)	(0.671)	(0.378)
IV F-Stat	28.887	14.0937	16.4872
Control variables	Y	Y	Y
Province × Time dummy	Y	Y	Y
N	2678	959	1719
adj. R^2	0.855	0.729	0.876

Note: Standard errors are in the parentheses. *** 1%. Other control variables and the province -year fixed effect have been controlled but are not listed in the table.

Secondly, minimum wage regulations. In 2004, China promulgated minimum wage laws, which may also drive up both housing prices and wages in eastern cities since 2003. Therefore, we collected minimum wage data for 286 prefecture-level cities. The trend of minimum wage presented in Fig. 6 shows that minimum wages are increasing in both the eastern and inland cities. We have calculated the ratio of the average minimum wage in the eastern cities to the inland cities and found that the ratio decreased between 2001–2010 (depicted in Fig. 7), which means that the average minimum wage can't have driven a faster growth of both housing prices and wages in the eastern cities. In Table 8, we added the minimum wage as a control variable in the regressions. We found a similar pattern again as before, which means that minimum wage is not a confounding factor to our results. We also found that the minimum wage would drive up wages in the inland cities. In the inland cities, the average wage may be close to the minimum wage; the implementation of minimum wage regulation would thus cause an increase in wages.

Thirdly, *hukou* system. In the theoretical model, we do not consider *hukou* system only for simplification. In reality, *hukou* system is a major obstacle of migration that may both affect housing prices and wages. In Chinese cities, 270 million migrants live in cities in 2015, but do not have local *hukou* (Lu and Xia, 2016). In Eastern cities, the proportion of non-resident population is higher. According to the 2005 population survey, 15.12% of the urban

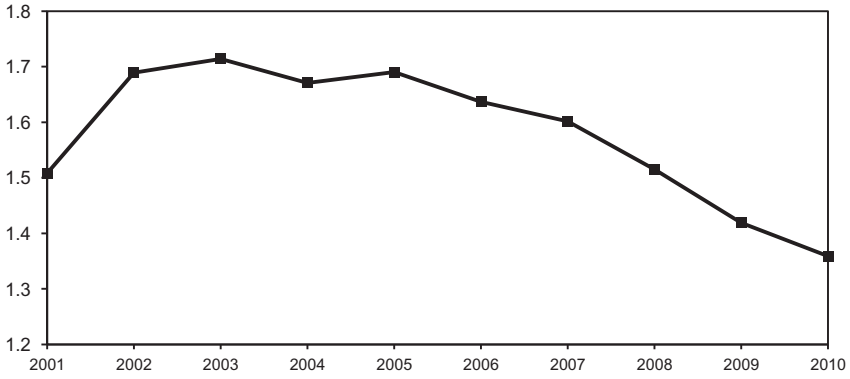

Fig. 5. The ratio of product per worker in the Eastern to the Inland.

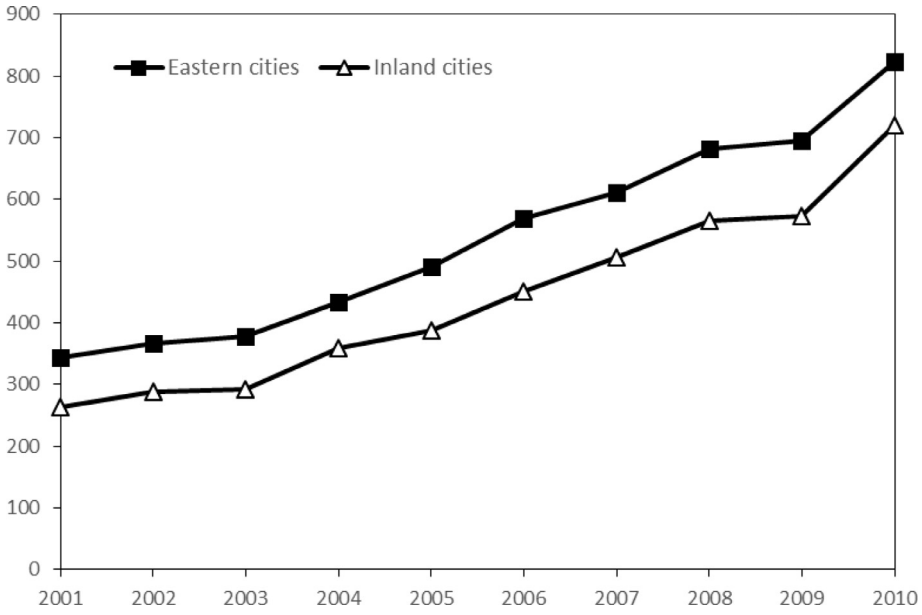

Fig. 6. The trend of minimum wage.

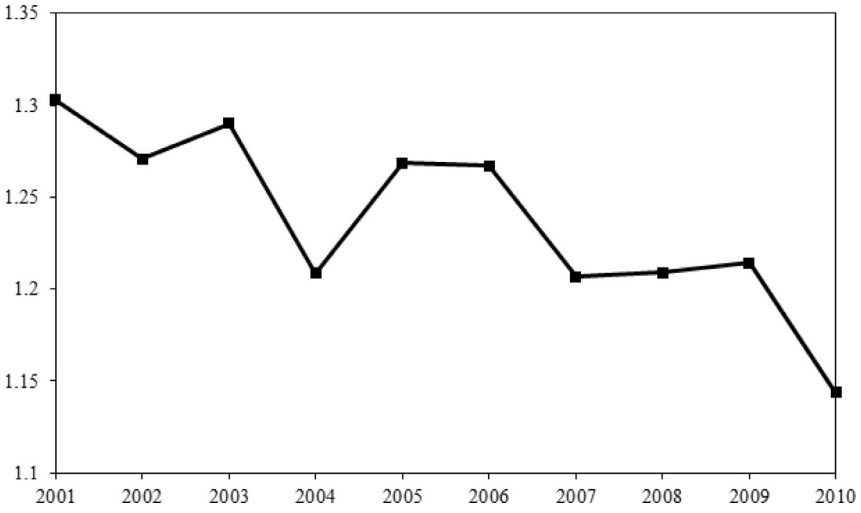

Fig. 7. The ratio of minimum wage between the inland and eastern regions.

Table 9
Robustness check: adding Hukou index.

lnwage	OLS	IV	OLS
lnhp	0.278***	1.209**	0.300***
	(0.0546)	(0.500)	(0.0619)
Hukou index	0.0412	−0.199	0.348
	(0.0399)	(0.134)	(0.423)
Lnhp × hukou index			−0.0380
			(0.0522)
_cons	4.313***	−0.479	4.297***
	(0.716)	(2.705)	(0.709)
N	432	432	432
adj. R^2	0.961	0.811	0.961

Note: Standard errors are in the parentheses. *** 1%, ** 5%. Other control variables and the province -year fixed effect have been controlled but are not listed in the table.

population have no local urban *hukou* in the eastern region, while only 4.03% in the inland. However, in our theoretical model that focuses on the effect of land supply and housing prices, the *hukou* is assumed as a fixed effect. In the empirical estimation of how housing prices affects wages, we tried to control for a *hukou* measurement, which is constructed by Wu and Zhang (2010) for 45 Chinese cities. The higher the index is, the more difficult for the migrants to obtain a local *hukou*. As we expected, after controlling for this index, the results of how housing prices affect wages do not change much as Table 9 shows. In the first column, the coefficient of housing price is 0.278, significant at the 1% level, but the coefficient of *hukou index* is insignificant. The IV estimation in the second column also shows similar results. We include the interaction term of housing price and *hukou* index to investigate the heterogeneous effect of housing prices, and find that the interaction term is insignificant. This is very intuitive, because the *hukou* index only has cross-sectional variation, while the housing prices and wages have within-city variations. But one caveat for Table 9 is that the 45 cities are not nationally representative and the sample size and estimation efficiency are reduced much.

8. Conclusions

This paper first used city level data to investigate how housing prices affect wages. Additionally, we used instrument variables and East-Inland border samples to explore the mechanisms behind this relationship. We found that the inland-favoring land policies caused a slower growth in the construction land supply in the eastern cities, and then drove up housing prices, before finally raising wages in the eastern cities. However, such an effect doesn't exist in the inland cities where the construction land supply was sufficient. We also partialled out the effects of GDP per capita and minimum wage on average wages. These results are robust in various checks. Our paper has contributed to the literature on the effects of land supply regulation and housing prices. We have also provided a new insight to understand the rapid rise of both housing prices and wages in China, especially in the Eastern region since 2003. In addition, our research has evaluated the effects of China's place-based policies by using land supply control to equalize regional development. The implication of the study is that more land use quotas should be allocated to the places receiving migrants, which is the East, especially the large cities, in China. Thus, both the efficiency and growth potential can be improved.

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