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GOVERNMENT INTERVENTION, LAND MARKET, AND URBAN DEVELOPMENT: EVIDENCE FROM CHINESE CITIES

JIPENG ZHANG, JIANYONG FAN and JIAWEI MO*

This article investigates how government intervention in land market affects China's urban development, using data from prefecture-level cities between 2000 and 2010. We find that government intervention enlarges the impact of positive productivity shocks on housing price appreciation, through mainly the government control over residential land supply. However, we find no significant evidence that high government intervention constrains population growth and leads to wage increase. Such patterns of urban dynamics can be explained by the fact that migrant workers are the driving force behind China's urbanization, but they have limited housing demand and are not well compensated. (*JEL* P52, R12, H11)

I. INTRODUCTION

Land market plays an essential role in urban development because land availability is a fundamental physical constraint on the expansion of cities. Institutional arrangements related to land use, such as government control and regulation, can significantly affect urban dynamics. This article investigates how government intervention in land market affects urban development using data from prefecture-level cities in China between 2000 and 2010, a period of rapid urbanization, during which the proportion of the urban population increased from 36% to 50%. China's urban development can have a profound impact not only on the sustainability of China's economic growth but also on the stability of global economy as China is more integrated with the world. Moreover, China's experience can provide useful insights for other developing countries that are in a similar transition to that in China. Therefore, an empirical analysis of China's urban development and its relationship with land market has both academic value and policy implications.

We first document the stylized facts of China's urban development and its land market. There is a significant change in the distribution of the residential population across China. Over time, migrant workers—those who work and live in a city for more than 6 months, but have no local household registration in that city—have increased dramatically and account for a larger proportion of the residential population in most cities. For example, from 2000 to 2010, migrant workers in Shanghai increased from 3.5 to 8.9 million, among which the majority

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ABBREVIATIONS

CPI: Consumer Price Index
FAR: Floor Area Ratio
FDI: Foreign Direct Investment
GMM: Generalized Method of Moments
OLS: Ordinary Least Square
SOE: State-Owned-Enterprise
SPV: Special-Purpose Vehicle

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(4.7 million) of the increase came from the later period between 2005 and 2010, and the share of migrant workers in the total residential population increased from 21% to 39%. Importantly, the change in migrant workers in Chinese cities is highly correlated with the change in residential population, with a correlation coefficient of .81 and .93 in the periods from 2000 to 2005 and from 2005 to 2010, respectively.

According to China's constitution, land is either collective owned or state owned. However, local governments have the de facto control over city planning and land use. After the fiscal reform in 1994, the separating tax system authorized local governments to collect and retain most of the revenues generated from land transaction and development. Since then, land has become the most valuable asset for local governments to strategically compete for investment and promote economic growth. Land-related revenues and local government debts backed by land assets are the two major resources that local governments rely on to finance local public goods and stimulate local economy. Land-sale revenue itself can account for more than 30% of the total fiscal revenue of a local government. Land is also used as collateral for about 37% of local government debt, according to the auditing report published by the National Audit Office in 2014.

Using the data of land sale from Chinese cities, we find that the total revenue of land sale has steadily increased from just 50 billion Yuan (unit for Chinese currency, Renminbi) in 1999 to about 1.4 trillion Yuan in 2007. On average, the land sold for industrial use accounts for 55% of the total land sale, however, the revenue from industrial land sale accounts for just about 25% of the total revenue. This largely reflects the fact that the price of land for industrial use is much lower than the price of land for residential and commercial use. The mean price of industrial land is below 1 million Yuan per hectare for most of the years, while the mean price of residential and commercial land is more than 11 million Yuan per hectare.

The large price difference between industrial and residential land is related to the public ownership of land and China's political economy (Xu 2011). Since local governments have the monopolist power to control land market, they often provide industrial land use with low price in order to compete for more investment and better economic performance. Meanwhile, local governments can limit the residential and commercial land supply and push up the price to obtain higher revenue, since housing and commercial services are localized consumption and local governments face much less competition.

We develop a spatial equilibrium model with a dual land market in order to illustrate the relationship between China's urban development and its land market. The spatial equilibrium in the tradition of Rosen (1979) and Roback (1982) predicts that positive productivity shock leads to increases in population, wage, and housing price in cities with low housing supply constraint (Glaeser, Gyourko, and Saks 2006). However, in cities with high housing supply constraint, productivity growth only leads to increases in housing price and wage but not population growth. In a similar spirit, but through different mechanisms, we theoretically demonstrate and empirically test how China's urban dynamics can be affected by government intervention in the land market, which is a fundamental institutional constraint on land use and housing supply in China.

Empirically, we construct a measure of government intervention for all Chinese cities utilizing the price information of land sold through market-based mechanism and negotiation, which essentially reflects the price differences between residential and industrial land because the majority of land sold through market-based mechanisms is residential land and the land sold through negotiations is mostly industrial land. We rank all the prefectural cities according to the price ratio between residential and industrial land. Then, we define a dummy variable for high government intervention that is equal to 1 for the cities in the 30th percentile of the rank and is equal to 0 otherwise.

From the perspective of identification, we rely on the spatial *difference in the differences* between the prices of residential and industrial land across Chinese cities, in order to evaluate the impact of government intervention on urban dynamics. In the regression analysis, our "difference-in-differences" construction of government intervention and the use of dummy variable for high government intervention can alleviate the problem that we cannot control for the unobserved features of industrial and residential land, such as location, quality, and government corruption.

The main finding is that positive productivity shocks lead to a larger increase in housing prices in cities with high government intervention, which supports the hypothesis from the spatial equilibrium model. The impact of government intervention on housing prices comes from two channels: one is through lower supply of

residential land and hence less supply of housing services; the other is through lower price of industrial land that generates higher demand for workers and housing services. In China's housing market, the first channel is more important than the second channel, because government control over the supply of residential land has a larger impact than the limited housing demand from migrant workers. Most migrant workers choose not to move with their families because of the household registration system and their limited access to certain public services, such as access to public school and health insurance. Many migrant workers live in factory dorm, urban village, or share a tiny apartment with their peers. Our theoretical model illustrates how heterogeneous housing demand of migrant workers affects urban development.

In contrast to the evidence from the United States (Glaeser, Gyourko, and Saks 2006), government intervention does not constrain population growth and has no significant effect on wage increase in most empirical specifications. The stylized facts of China's urban development documented in the paper can explain these empirical findings. During China's rapid urbanization, the wage growth of migrant workers is relatively slow because of the large supply of migrant workers in most cities. Hence, industrial land expansion leads to higher demand for labor, but firms need not pay higher wage. On the other hand, less residential land supply should drive up wage because of higher living cost, but the limited housing demand from migrant workers alleviates this effect.

We contribute to the literature on how government policy and land market can affect urban development (Glaeser and Gyourko 2005; Glaeser, Gyourko, and Saiz 2008; Saiz 2010). Previous studies focus mainly on the impact of land use regulation on urban dynamics (Capozza and Helsley 1989; Davis and Palumbo 2008; Quigley and Raphael 2005), and most of them study the related phenomena in developed countries. Using the data from China, we investigate these issues from a distinct angle of government intervention that is caused by the public ownership of land and the structure of China's political economy.

Our study also relates to the literature on the relationship between the local political economy and land market (Gyourko and Tracy 1989; Lichtenberg and Ding 2009). Han and Kung (2013) find evidence that China's local governments shifted their efforts from fostering industrial growth to "urbanizing" China through land market. There is another related literature on Chinese cities and urbanization (Au and Henderson 2006; Baum-Snow et al. 2012; Deng et al. 2008; Song and Zenou 2012). Fu, Zheng, and Liu (2012) estimate the housing supply elasticity of Chinese cities and find that lower regulatory costs and land-use equity might raise housing supply elasticity. Our article is the first empirical study that investigates the effects of China's land market on its rapid urban development from 2000 to 2010.

In Section II, we document the stylized facts of China's urban development and land market. Section III presents a model that guides the empirical analysis. Section IV discusses the findings, and Section V concludes.

II. BACKGROUND

The distribution and change of population across cities are the central themes in urban development, especially for a large developing country like China. In this section, we first document the main features and dynamics of residential population and migrant workers in China. Then, we discuss the spatial differences in housing prices and wages that are the two other key variables characterizing urban dynamics. Lastly, we document the key institutional features of China's land market. The data resources and variables are summarized in Table 1 and the summary statistics are presented in Table 2.

A. Residential Population

Residential population is a measure of people living and working in a city. Some commonly available statistics on population in China, however, only account for the residents who have household registration in a city. Because migrant workers without registration can account for a large proportion of the actual residential population in Chinese cities, we need the data that can provide a relatively accurate measure of migrant workers. The best data available are the population censuses in 2000 and 2010 and the 1% population survey in 2005. Hence, we study the changes in residential population from 2000 to 2005 and from 2005 to 2010. Because no data are available to calculate city population of a prefecture, we use the population change among prefectures as a proxy for the change among cities.

Many prefectures experienced large population increases in the period between 2000

TABLE 1
Definition and Data Sources of Main Variables

Variables	Definition and Time	Sources	Obs.
Population	Residential population 2000, 2005, 2010	Census 2000, 2010, Population Survey 2005	570
Wage	Nominal value in 2000, 2005, 2009	CEIC China Database 2000–2010	551
Housing price	Nominal value in 2002, 2005, 2009	CEIC China Database 2000–2010	570
FDI	Accumulated stock in 2000 and 2005	CEIC China Database 1996–2005	542
Human capital	Years of schooling in 2000 and 2005	Census 2000 and Population Survey 2005	516
Land prices	Land sale price per hectare 2003–2008	Land Resource Statistical Yearbook 2004–2009	574
Income gap	Urban-rural ratios in 2000 and 2005	City Statistical Yearbook 2001, 2006	574
Library resource	Books per capita in 2000 and 2005	City Statistical Yearbook 2001, 2006	546
Health care	Hospital beds per capita in 2000 and 2005	City Statistical Yearbook 2001, 2006	546

TABLE 2
Summary Statistics of Main Variables

	Population Level (1,000)		Housing Price Level (Yuan/m^2)		Wage Level (Yuan/Year)	
	2000	2010	2002	2009	2000	2009
Mean	4,025.10	4,323.80	1,339.97	3,161.40	8,247.87	2,7573.28
SD	2,884.00	3,235.74	639.48	1,930.84	2,590.71	6,798.45
Median	3,373.10	3,539.86	1,186.00	2,598.00	7,583.00	2,6547.67
	Population Change (1,000)		**Housing Price Change (Yuan/m^2)**		**Wage Change (Yuan/Year)**	
	2000–2005	2005–2010	2002–2005	2005–2009	2000–2005	2005–2009
Mean	123.21	175.50	567.04	1,262.11	7,373.11	1,2032.86
SD	327.79	561.57	556.03	1,044.89	2,875.73	3,289.96
Median	82.28	56.82	431.00	1,090.00	6,738.90	1,1927.29
	Population Growth (%)		**Housing Price Growth (%)**		**Wage Growth (%)**	
	2000–2005	2005–2010	2002–2005	2005–2009	2000–2005	2005–2009
Mean	3.58	3.25	43.65	67.32	91.41	81.29
SD	6.14	7.95	36.69	30.68	31.56	23.39
Median	2.93	2.26	37.16	65.54	87.24	80.15

	Accumulated FDI (Yuan in Log)			Human Capital (Years of Schooling)		
	2000	2005	Total	2000	2005	Total
Mean	6.96	7.86	7.43	8.35	8.62	8.48
SD	2.23	2.18	2.24	0.94	1.01	0.98
Median	7.24	7.98	7.59	8.39	8.58	8.49

and 2010. Among the 25 prefectures that have the largest population increase, most are in the eastern region of China, and some are the regional economic centers in the middle and west, such as Chengdu, Zhengzhou, Wuhan, Hefei, and Wulumuqi. The two national economic centers, Shanghai and Beijing, have the largest population increases with 6.28 and 6.04 million, respectively, between 2000 and 2010, followed by two fast-growing metropolitan areas benefiting from China's economic reform and opening up: Suzhou and Shenzhen, with 3.67 and 3.35 million increase, respectively.

There is a larger population change in the second period between 2005 and 2010 than in the first period between 2000 and 2005. For example, in Shanghai and Beijing, population increased by 5.24 and 4.23 million in the second period, but only 1.04 and 1.81 million in the first period. This implies that political and economic barriers on population move across regions have been removed to a certain extent, which leads to a significant increase in population mobility.

On the other end of the population change, there are also prefectures that lost population significantly, most of which are in the

less-developed provinces with large population bases, including Sichuan, Hubei, Henan, and Anhui. From 2000 to 2010, the residential population in Chongqing, Ziyang, and Huanggang had the largest decrease with 1.67, 1.03, and 0.95 million, respectively. Surprisingly, four prefectures in the north of the coastal province Jiangsu also have large population decreases, which might be attributed to their easy access to the more prosperous economic regions in Southern Jiangsu and Shanghai.

According to the growth rate of residential population from 2000 to 2010, 6 of the top 10 prefectures come from the east, including Xiamen (72%), Suzhou (54%), Shenzhen (48%), Beijing (45%), Huizhou (43%), and Sanya (42%); others come from the west, including Yinchuan (69%), Wulumuqi (49%), Kelamayi (45%), and Jiayuguan (45%) that have relatively small population sizes in 2000. According to the total residential population in 2010, the largest metropolitan areas are Chongqing, Shanghai, Beijing, and Chengdu, with 28.85, 23.02, 19.61, and 14.05 million people, respectively. Population level is not only determined by economic potential but also geographical size, so we focus on population change in our study.

B. Migrant Workers

The movement of migrant workers across cities is important in explaining the change in residential population, because migrant workers account for a large proportion of the residential population in many cities. Shanghai, Shenzhen, and Beijing have the largest numbers of migrants, with 8.9, 7.7, and 7.04 million in 2010. Migrant shares in residential population can be as high as 78% for Dongguan, followed by three other prefectures in Guangdong province: Shenzhen (74%), Zhongshan (52%), and Foshan (48%).

Over time, both the scale and the speed of migration increased. Migrant flows increased significantly and the distribution of migrants expanded to a much larger region toward western China from 2000 to 2010. Shanghai, Beijing, and Suzhou have the largest increases in migrant workers from 2000 to 2010, with respectively 5.39, 4.55, and 3.07 million (113%, 97%, and 72% growth relative to 2000). Most of the change in migrants comes from the second period from 2005 to 2010, which is similar to the change in residential population.

Most importantly, we find that the change in migrant workers can explain most of the change in residential population. Figure 1 demonstrates a strong positive correlation between the change in migrants and the change in residential population. The correlation coefficient is .93 for the period between 2005 and 2010 and is increased significantly from that of 0.81 for the period between 2000 and 2005. This further justifies our choice to use the change in residential population among prefectures as a proxy for the population change in the cities, because migrant workers mostly work and live in the urban sector. Chen and Song (2014) find that urbanization accounts for 80.4% of the total urban population growth of 211 million in the 2000s. Population increase has a strong positive correlation with the initial population level and this relation is stronger in the second period between 2005 and 2010, as seen from Figure 2.

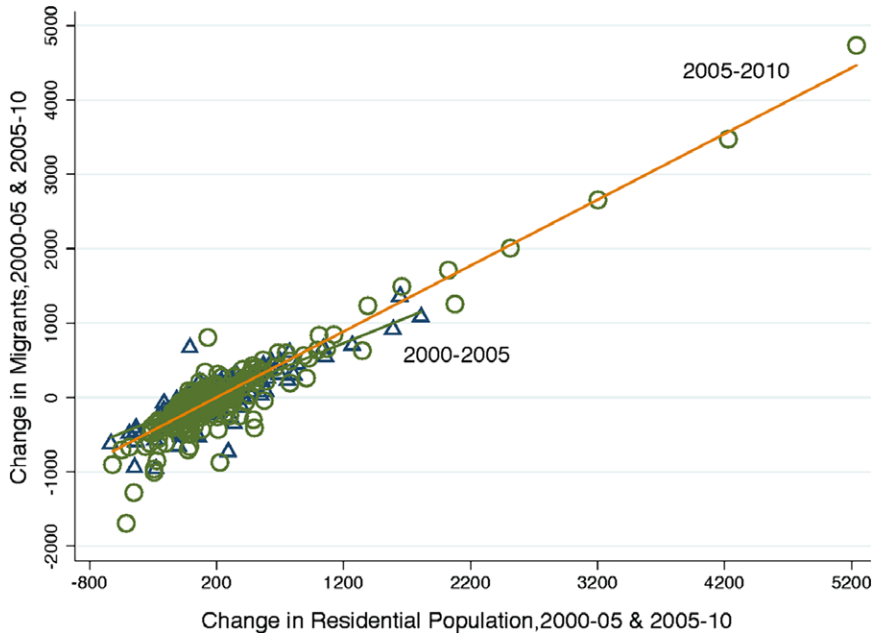
C. Housing Price and Wage

Housing price (in current price) has increased dramatically since 2002 when a private housing market started to emerge gradually. The average housing price in 2009 is 3,161 Yuan/m^2, more than twice the price in 2002. Between 2002 and 2009, Wenzhou, Beijing, Shenzhen, and Shanghai had the largest housing price appreciation, with an increase of 10,745, 9,035, 8,813, and 8,706 Yuan/m^2, respectively. Housing price has increased much more in the second period from 2005 to 2009 than in the first period from 2002 to 2005, according to Table 2. The increase in housing price is strongly correlated with the initial price level, especially in the second period from 2005 to 2009, as shown in Figure 3.

The average annual wage (in current price)[1] increased by 7,373 Yuan/year in the period from 2000 to 2005 and 12,033 Yuan/year in the period from 2005 to 2009. Between 2000 and 2009, Beijing and Shanghai had the largest wage increases with 41,429 and 39,805 Yuan/year. The wage change has salient difference from the changes in population and housing price. Overall, the wage growth rate in the second

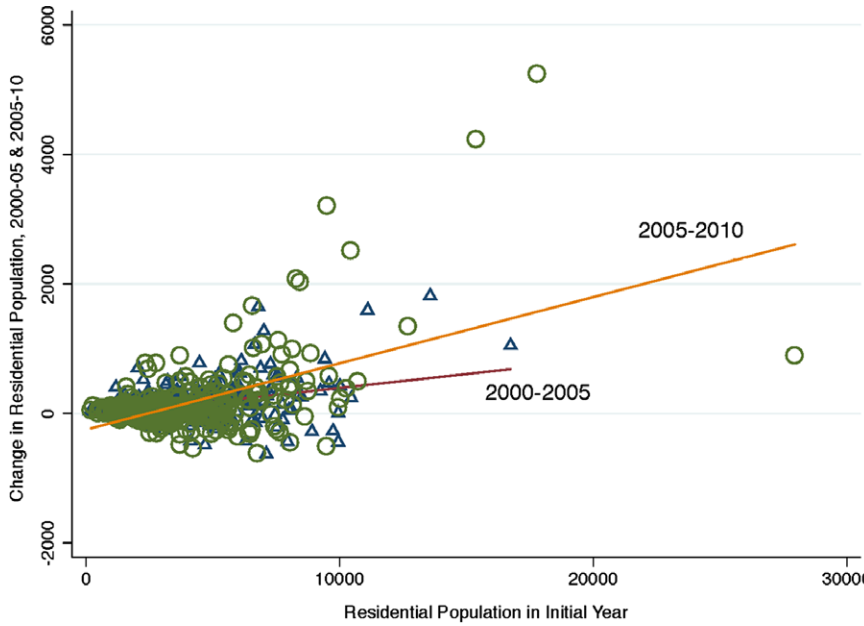
1. We follow the literature and use nominal wage (Glaeser, Gyourko, and Saks 2006; Roback 1982) for the following reasons. First, the price information, typically consumer price index (CPI), to deflate nominal price in each city is not easy to get and might not be comparable if cities use different baskets of commodity to construct the price index. Second, deflating both wages and housing prices complicates the analysis because CPI might affect wage and housing price differently. Third, nominal wage and housing price are modeled in theory and thus treated as the dependent variables, which is more consistent.

FIGURE 1
Changes in Residential Population and Migrant Wokers: 2000–2005 and 2005–2010



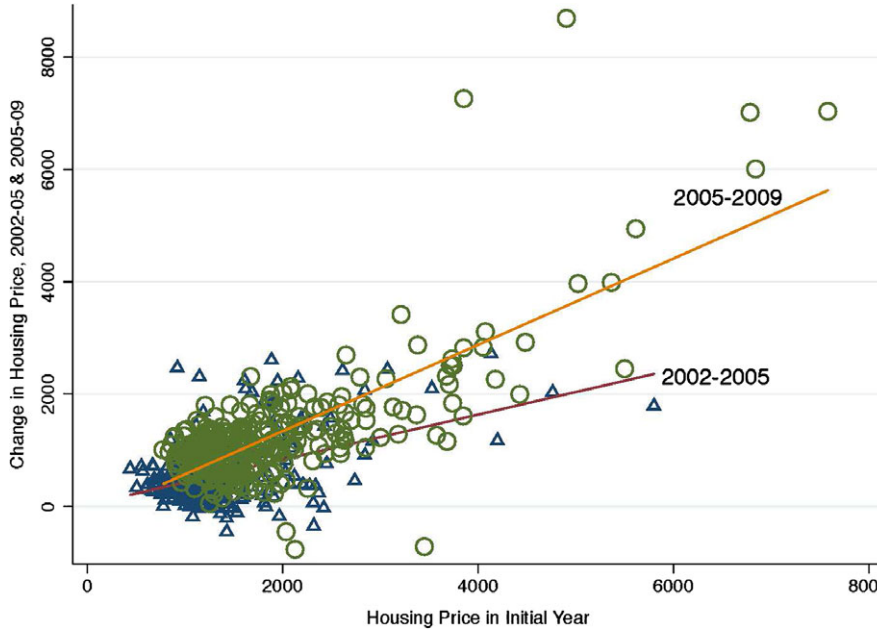
Note: The triangle points refer to the period 2000–2005; the circle points refer to the period 2005–2010.

FIGURE 2
Changes in Residential Population and Initial Population: 2000–2005 and 2005–2010



Note: The triangle points refer to the period 2000–2005; the circle points refer to the period 2005–2010.

FIGURE 3
Changes in Housing Prices and Initial Housing Price: 2000–2005 and 2005–2009



Note: The triangle points refer to the period 2000–2005; the circle points refer to the period 2005–2009.

period is smaller than that in the first period. Wage increase has a strong positive correlation with the initial wage level in the first period, but this relation is much weaker in the second period, as seen from Figure 4.

D. Land Market

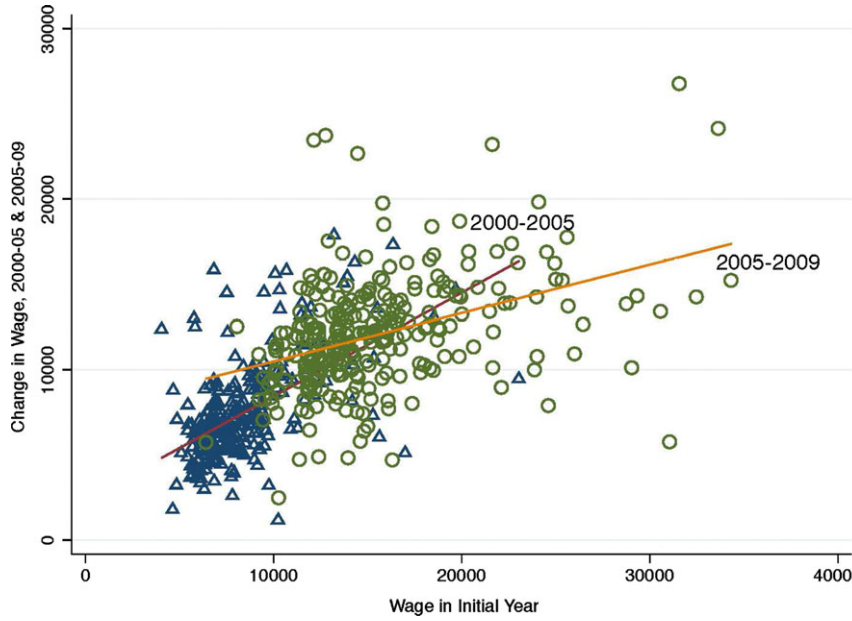
In the early 1950s, shortly after the founding of the People's Republic of China, all land was nationalized. Since then, urban residents have lived in public housing, until the privatization of state-owned housing in the 1990s (Wang 2010). A milestone is the 23rd Decree issued by China's State Council in 1998, which states that work units, mostly state-owned enterprises, were no longer allowed to develop residential housing for their employees (Wu, Gyourko, and Deng 2012). By the end of the 1990s, a private housing market had developed. The fundamental restriction on housing supply in China is land supply controlled by government.

Because of the rapid reduction of total arable land in 1990s, two principal laws regarding farmland preservation were passed: the Basic Farmland Protection Regulation in 1994 and the New Land Administration Law in 1999. The laws require local governments to designate a basic farmland protection zone and prohibit converting high-quality farmland to nonagricultural uses (Lichtenberg and Ding 2009).

The total area of land sale experienced a fast growth from about 50,000 hectares in 2000 to 200,000 hectares in 2003. The land sale grew again from 160,000 hectares in 2005 to 240,000 hectares in 2007, after which it dropped to 160,000 hectares in 2008 when central government intervened in the housing market with concerns over a housing bubble. The total revenue steadily increased from just 50 billion Yuan in 1999 to about 1.4 trillion Yuan in 2007, but the net revenue was less than 500 billion Yuan in 2007 and has increased less than the total revenue. Such aggregate trends reflect the impact of macroeconomic cycles and policy change, so it is important to control for the time fixed effects in empirical analysis.

According to the use category, the land sold for industrial use accounts for 55% of the total land sale; however, the total revenue from industrial land sale accounts for just about 25% of the total revenue, as shown in Figure 5. This largely reflects the price differences. From the left side of Figure 6, we can see that the price of land

FIGURE 4
Changes in Wages and Initial Wage: 2000–2005 and 2005–2009



Note: The triangle points refer to the period 2000–2005; the circle points refer to the period 2005–2009.

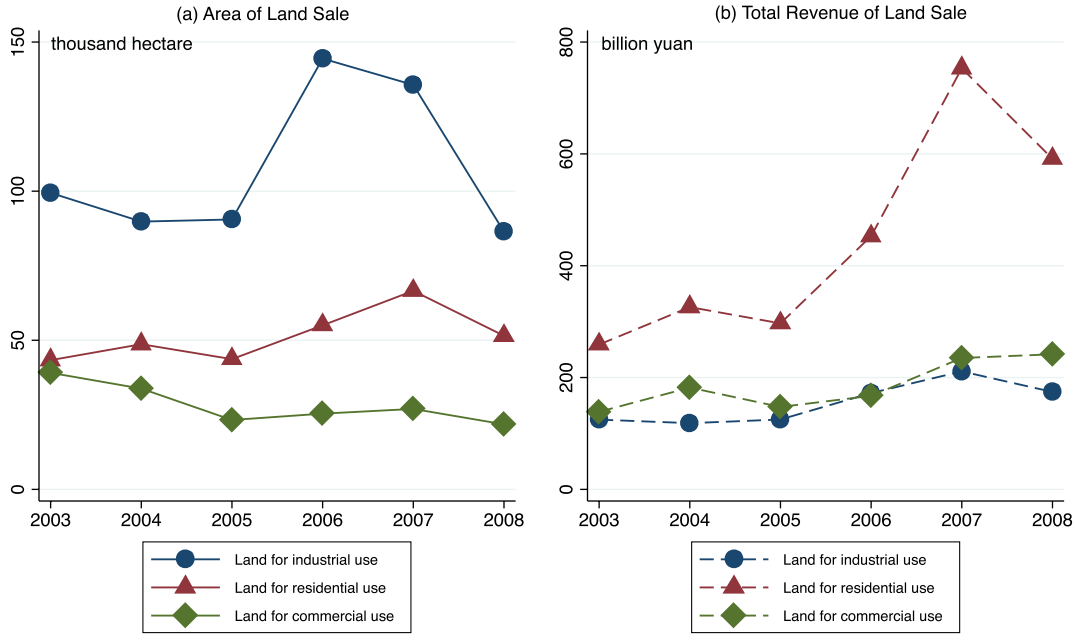
for industrial use is much lower than the price of land for residential and commercial use. The price of industrial land is below 1 million Yuan per hectare for most of the years, while the price of residential and commercial land can be more than 11 million Yuan per hectare.

Similar to the low price of industrial land, the price of the land sold through negotiation is also much lower than the price of the land sold through market-based mechanisms, including listing, bidding, and auction. This is not purely coincident. As shown in Table 3, 74% of the land sold through negotiation is land for industrial use; 81% of the land for industrial use is sold through negotiation. Meanwhile, most of the land sold through market-based mechanisms is residential and commercial land, with 78%, 87%, and 85% for listing, bidding, and auction, respectively. Hence, the difference between negotiated and market-based land price essentially represents the price difference between the industrial land use and residential and commercial land use. Because the price data of different land uses are not available, we use the price ratio between market-based and negotiated land as a proxy for the difference between residential and industrial land.

E. Government Behavior

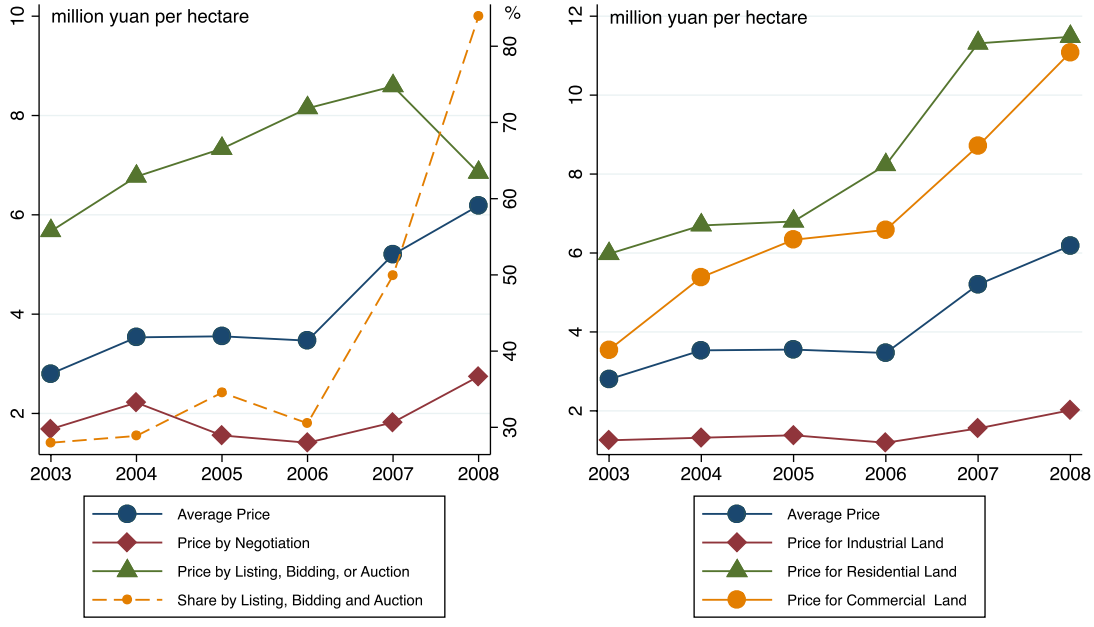
Under China's "decentralized authoritarian regime" (Xu 2011), political leaders in local governments compete for promotion through pursuing economic growth. There are two ways to achieve this in terms of land supply intervention. First, local governments increase industrial land supply for potential investors by offering much lower price of industrial land relative to the cost of acquiring these lands. Together with the implementation of various favorable tax policies, they are able to attract investments concentrating in different types of industrial zones, and therefore foster local production and raise employment. The second way is to use residential land to finance infrastructure investment and other government expenditure. Local governments tend to supply less residential lands in the hope of a high unit price of residential land. On one hand, they can collect more revenue from the leasing of residential lands. On the other hand, local government uses residential lands as collateral for bank loans of state-owned firms and local government debt. More discussion on fiscal incentives and policy choices of local governments can be found in Han and Kung (2013).

FIGURE 5
Total Area and Revenue of Land Sale by Use Category



Source: China Land and Resources Statistical Yearbook, 2004–09

FIGURE 6
Land Prices by Sale Method and Use Category



Source: China Land and Resources Statistical Yearbook, 2004–09

TABLE 3
Land Sale and Price by Sale Method and Use Category

	Share	Total Land Sale	Negotiation		Listing		Bidding		Auction	
	(%)	(1,000 hectare)	Share	Price	Share	Price	Share	Price	Share	Price
Industrial	55.02	646.23	73.57	1.30	19.83	2.84	10.81	1.76	10.84	3.00
Residential	14.50	170.32	8.50	4.43	28.02	7.10	18.80	1.52	25.47	9.77
Commercial	26.29	308.77	10.98	3.71	49.59	7.92	68.40	1.45	59.58	14.80
Other	4.19	49.22	6.96	1.97	2.56	4.90	1.32	2.62	4.11	3.49
Sum	100	1,174.54	100	1.77	100	6.32	100	1.16	100	12.15
	Share	**Total Land Sale**	**Industrial**		**Residential**		**Commercial**		**Other**	
	(%)	**(1,000 hectare)**	**Share**	**Price**	**Share**	**Price**	**Share**	**Price**	**Share**	**Price**
Negotiation	58.16	683.05	80.68	1.26	22.09	3.84	32.51	3.97	77.41	1.80
Listing	34.15	401.07	17.85	2.13	59.59	8.57	54.97	7.24	16.48	4.39
Bidding	2.15	25.26	0.39	1.46	5.56	13.23	3.01	11.76	0.94	4.92
Auction	5.55	65.15	1.09	3.03	12.76	15.54	9.52	9.52	5.16	1.54
Sum	100	1,174.54	100	1.43	100	8.68	100	6.53	100	2.24

Note: The price unit is million Chinese Yuan/hectare; all the shares are percentage.

The process of land acquisition and supply over the past 10 years is basically as follows. First, local governments establish a land reserve center for the management of all lands acquired from rural farming land or collective owned urban land. (See Lichtenberg and Ding 2009 for a more detailed discussion on land acquisition and government incentives.) Second, about 20%–30% of land reserves are transferred to residential land with 70 years of use right. In general, these residential lands are offered to market in the form of listing, bidding, or auction, with an average price 5–10 times as large as their cost. Meanwhile, 40%–50% of the land reserves will be transferred as industrial lands for the purpose of investment and economic growth. To attract outside investment, local governments negotiate the industrial land price directly with the investors, and the price is generally lower than the cost of land acquisition or even being offered at zero price (in the form of tax rebates or subsidies). Third, local governments may also allocate 30%–40% of the land reserves to state-owned firms, the so-called special-purpose vehicles (SPVs). SPVs can obtain banks loans from the commercial banks using land reserves as collaterals; the bank loans and leasing revenue of land are typically used to finance government infrastructure investments and other expenditure.

III. MODEL

Given the large scale of migrant workers in Chinese cities and the significant change in residential population across cities over time, the spatial equilibrium framework that relies on the assumption of population mobility seems a reasonable framework to study China's urban dynamics. We develop a spatial equilibrium model by incorporating the special institutional features of China's land market in order to better understand the stylized facts of China's urban development. The housing market works differently for migrants working in different sectors. In the industrial sector, living in the industrial land (factory dormitory) is probably more relevant; in the service sector, renting from local residents is more relevant. Hence, we explore the implications of the model with different housing market specifications.

We begin with an economy with I cities. Each city, indexed by i, has two types of workers, namely migrant workers and local workers. Migrant workers are those who work in a city but have no household registration in that city. We assume that migrant workers can move freely among cities until the same utility, $\bar{U}$, is achieved so that they are indifferent between locations. The population of migrant workers, M_i, is therefore endogenously given in the spatial equilibrium. Local workers are those who live and work in a city where they are registered. The local population with urban registration is exogenously given as $\overline{N}_i$ and is assumed to be immobile, which is reasonable because the majority of migrant workers come from rural areas. Both types of workers are employed by a representative firm in city i with total output of Y_i. Each city has a local government offering

industrial land, $\overline{L}_{f,i}$, for firms and residential land, $\overline{L}_{r,i}$, for residents exogenously.[2]

A. Firm

The production function of a representative firm is formalized as the following,

$$Y_i = A_i N_i^{\alpha} M_i^{\beta} L_{f,i}^{\gamma}, \tag{1}$$

where A_i represents city-specific productivity and $L_{f,i}$ is the industrial land used by firms. N_i and M_i measure, respectively, the number of local workers and migrant workers. α, β, and γ represent the share of two types of labor and land in the contribution to production, and $0 < \alpha, \beta, \gamma < 1$. The production function has diminishing returns to scale, that is, $\alpha + \beta + \gamma < 1$, capturing the omitted other inputs like capital.

The objective of a firm is to maximize its total profit, given the wage of two types of workers, $w_{i,n}$ and $w_{i,m}$. Solving the optimization problem of a firm gives the demand functions for two types of workers:

$$w_{i,n} = \alpha A_i L_{f,i}^{\gamma} N_i^{\alpha-1} M_i^{\beta}, \tag{2}$$

$$w_{i,m} = \beta A_i L_{f,i}^{\gamma} N_i^{\alpha} M_i^{\beta-1}, \tag{3}$$

where $w_{i,n}$ and $w_{i,m}$ are the wage level of local workers and migrant workers, respectively.

B. Housing Market

A representative worker (consumer) of type k in city i has the following preference for a composite consumption good $C_{i,k}$ that is treated as the numeraire, and housing $H_{i,k}$, given city-specific amenity level θ_i. We assume that the share of housing consumption in income, $0 < \sigma_k < 1$. The utility function of worker k is:

$$U_{i,k} = \theta_i C_{i,k}^{1-\sigma_k} H_{i,k}^{\sigma_k}, \tag{4}$$

where $k = \{n, m\}$ represents local and migrant workers, respectively. A worker maximizes utility given wage, $w_{i,k}$, and the rental price of housing, r_i, under the budget constraint:

$$C_{i,k} + r_i H_{i,k} = w_{i,k}. \tag{5}$$

2. A complete analysis on the endogenous determination of land supply requires a formalization of government objective function and local public finance. Because the objective of our empirical analysis is mainly on urban dynamics, we leave this for future work.

Note that both types of workers live on residential land leased from government, and they are facing the same rental price, r_i.

With the above formalization, the housing demand of worker k is

$$H_{i,k} = {}^{\sigma_k w_{i,k}}/_{r_i}. \tag{6}$$

And the total demand for housing in city i is

$$H_i^d = H_{i,n} N_i + H_{i,m} M_i = {}^{(\sigma_n w_{i,n} N_i + \sigma_m w_{i,m} M_i)}/_{r_i}. \tag{7}$$

For simplification, we assume both the residential land supply $L_{r,i}$ and the floor area ratio (FAR) κ_i are determined by local government, and housing supply equals the residential land supply multiplied by a city-specific FAR. Given the housing supply,

$$H_{i,k}^s = \kappa_i \overline{L}_{r,i}, \tag{8}$$

and the total demand for housing (7), we can derive the equilibrium housing price[3]:

$$r_i = {}^{(\sigma_n w_{i,n} N_i + \sigma_m w_{i,m} M_i)}/_{\kappa_i \overline{L}_{r,i}}. \tag{9}$$

C. Labor Market

With the spatial equilibrium definition that equal utility $\bar{U}$ of worker k should be achieved among all cities, we can further solve for the equilibrium employment of migrant workers, M_i, as the following:

$$M_i = \lambda_{m,i}^{\frac{1}{1-\beta(1-\sigma_m)}} \overline{L}_{r,i}^{\frac{\sigma_m}{1-\beta(1-\sigma_m)}} \left(A_i \overline{L}_{f,i}^{\gamma} \overline{N}_i^{\alpha} \right)^{\frac{1-\sigma_m}{1-\beta(1-\sigma_m)}}, \tag{10}$$

where $\lambda_{m,i} = \beta \left(1 - \sigma_m\right)^{1-\sigma_m} \sigma_m^{\sigma_m} \left(\alpha\sigma_n + \beta\sigma_m\right)^{-\sigma_m} \overline{U}^{-1} \theta_i$.

With the employment of migrant workers, we can then solve for the equilibrium wages:

$$w_{i,m} = \beta \lambda_{m,i}^{\frac{-(1-\beta)}{1-\beta(1-\sigma_m)}} \overline{L}_{r,i}^{\frac{-(1-\beta)\sigma_m}{1-\beta(1-\sigma_m)}} \left(A_i \overline{L}_{f,i}^{\gamma} \overline{N}_i^{\alpha} \right)^{\frac{\sigma_m}{1-\beta(1-\sigma_m)}}, \tag{11}$$

$$w_{i,n} = \alpha \lambda_{m,i}^{\frac{\beta}{1-\beta(1-\sigma_m)}} \overline{L}_{r,i}^{\frac{\beta\sigma_m}{1-\beta(1-\sigma_m)}} \left(A_i \overline{L}_{f,i}^{\gamma} \overline{N}_i^{\alpha} \right)^{\frac{1}{1-\beta(1-\sigma_m)}} \overline{N}_i^{-1}. \tag{12}$$

3. Here, the housing price should be understood in terms of the measure of income, that is, monthly or yearly payment for housing. Alternatively, we can assume that the equilibrium rental price that equals a multiple of housing price, $p_i = \mu r_i$ ($\mu < 1$). Both the theoretical and empirical will not be affected by this numerical change.

Given the equilibrium wages and employment, the equilibrium rental price of housing can be rewritten as:

$$r_i = \left(\alpha\sigma_n + \beta\sigma_m\right)\lambda_{m,i}^{\frac{\beta}{1-\beta(1-\sigma_m)}}\overline{L}_{r,i}^{\frac{-(1-\beta)}{1-\beta(1-\sigma_m)}} \times \left(A_i\overline{L}_{f,i}^{\gamma}\overline{N}_i^{\alpha}\right)^{\frac{1}{1-\beta(1-\sigma_m)}}. \quad (13)$$

D. Comparative Statics

Proposition 1 summarizes the comparative statics on the changes in the population of migrant workers in responding to exogenous productivity shock A_i and government intervention through controlling residential land supply $L_{r,i}$ and industrial land $L_{f,i}$.

PROPOSITION 1. *Population of migrant workers in city i increases when residential land supply increases or industrial land supply increases, that is,* $\partial M_i/\partial L_{r,i} > 0$, $\partial M_i/\partial L_{f,i} > 0$.

While Proposition 1 shows that the expansion of either industrial land or residential land leads to larger numbers of migrant workers, the mechanism of these two kinds of land policy is quite different. The increase of industrial land supply links to higher marginal production of migrant workers and thus higher labor demand, which pushes up wage level and therefore attracts more migrants. The increase of residential land supply, on the other hand, relates to lower living cost (lower housing price) and hence higher utility. Migrant workers will move to those cities with more residential land supply until housing price converges to equilibrium level.

Interestingly, from wage Equations (11) and (12), one may find that the wage of local workers and migrant workers responds quite differently to the land policies, which we summarize as Proposition 2:

PROPOSITION 2. *Wage of migrant workers in city i increases when residential land supply decreases or industrial land supply increases, that is,* $\partial w_{i,m}/\partial L_{r,i} < 0$, $\partial w_{i,m}/\partial L_{f,i} > 0$. *However, wage of local workers increases when residential land supply increases or industrial land supply increases, that is,* $\partial w_{i,n}/\partial L_{r,i} > 0$, $\partial w_{i,n}/\partial L_{f,i} > 0$. *Moreover, local workers benefit more from industrial land expansion than migrant workers in terms of wage growth, that is,* $\partial w_{i,n}/\partial L_{f,i} > \partial w_{i,m}/\partial L_{f,i}$.

For migrant workers, when their wage satisfies the condition of spatial equilibrium, more residential land supply leads to lower housing cost, and hence less wage increase for migrant workers. For local workers, however, they are assumed to be immobile and their labor supply is inelastic, which means their wages are totally determined by labor demand of firms in Equation (2). In this case, more residential land supply leads to larger numbers of migrant workers as Proposition 1 tells us, and therefore higher labor demand of local people. On the other hand, the increase of industrial land supply leads to higher wage of both local and migrant workers as both of their marginal production increase. Overall, local workers benefit more from this process because they can enjoy the spillover effect of the growing number of migrant workers which leads to an increase in labor demand for local workers.

What is the implication of Proposition 2? When local governments decide to apply expansionary land policy of industrial land to attract outside investment, local workers tend to benefit more from the industrial land expansion due to different mobility of local workers and migrant workers. The more migrants rush into cities, the larger their wage gap is in those cities.

Finally, there are different effects of land policies on housing price, which we summarize as Proposition 3:

PROPOSITION 3. *Rental price of housing in city i increases when residential land supply decreases or industrial land supply increases, that is,* $\partial r_i/\partial L_{r,i} < 0$, $\partial r_i/\partial L_{f,i} > 0$.

The economic intuition of Proposition 3 is straightforward. Other things being equal, less residential land supply makes houses scarcer and housing price higher. More industrial land supply increases labor demand and therefore pushes up wage level as well as workers' purchasing power, and thus housing demand increases.

E. A Special Case

In this section, we assume that migrant workers spend nothing on housing, which is more reasonable than it appears. Numerous case studies have documented the fact that migrant workers do not buy a housing unit, and often live in the factory dorm, urban village, or rent just a tiny room (even simply a bed). Hence, the total demand for housing in city i becomes $H_i^d = H_{i,n}N_i = \sigma_n w_{i,n}N_i/r_i$.

The equilibrium employment of migrant workers, M_i, is the following:

$$M_i = \left(\lambda_{m,i} A_i \overline{L}_{f,i}^{\gamma} \overline{N}_i^{\alpha}\right)^{\frac{1}{1-\beta}}, \tag{14}$$

where $\lambda_{m,i} = \beta \bar{U}^{-1} \theta_i$. The equilibrium wages of two types of workers are:

$$w_{i,m} = \beta \lambda_{m,i}^{-1} = \overline{U} \theta_i^{-1}, \tag{15}$$

$$w_{i,n} = \alpha \lambda_{m,i}^{\frac{\beta}{1-\beta}} \left(A_i \overline{L}_{f,i}^{\gamma} \overline{N}_i^{\alpha}\right)^{\frac{1}{1-\beta}} \overline{N}_i^{-1}, \tag{16}$$

Given the equilibrium wages and employment, the equilibrium rental price of housing can be rewritten as:

$$r_i = \left(\alpha \sigma_n\right) \lambda_{m,i}^{\frac{\beta}{1-\beta}} \left(\kappa_i \overline{L}_{r,i}\right)^{-1} \left(A_i \overline{L}_{f,i}^{\gamma} \overline{N}_i^{\alpha}\right)^{\frac{1}{1-\beta}}. \tag{17}$$

From Equations (14), (15), (16), and (17), we can see that migration, wage, and housing price are affected by industrial land expansion similar to those in Propositions 1–3. But, the supply of residential land supply now has no impact on migration decision and the wages of both types of workers. This is a very different prediction from standard urban theory and a special feature of China's institutional arrangement. This implies that, in China, constraints on housing supply lead to housing price appreciation, but might not be a barrier for migrant workers to move to cities and will not drive up wages. This case might be the best specification for many Chinese cities.

F. An Alternative Formalization of Housing Market

In this section, we introduce a housing market for migrant workers provided by local workers. In this setting, local workers can be understood as workers who worked for those state-owned-enterprises (SOEs) before the housing market reform. After the privatization of public housing in the late 1990s and early 2000s, the workers who were employees of SOEs and the local residents in the urban area were endowed with a fixed share of land.

We assume that each local worker was born with a land endowment as large as $\overline{L}_o$, and they lease their land to migrant workers. Suppose that somehow only local workers could acquire residential land from government (e.g., due to household restriction) and they all live on residential land market, while migrant workers live on the endowed land leased by local people. Another interpretation is that $\overline{L}_o$ is a proportion of the industrial land L_f.

Because two types of workers live in two different housing markets, they are facing different rental prices, $r_{i,m}$ and $r_{i,n}$. Now the budget constraint of migrant workers is modified as

$$C_{i,m} + r_{i,m} H_{i,m} = w_{i,m}, \tag{18}$$

and the budget constraint of local workers is

$$C_{i,n} + r_{i,n} H_{i,n} = w_{i,n} + r_{i,m} L_o. \tag{19}$$

Note that the income of local people consists of two parts. One is the general wage given by firms and the other is rent from migrant workers. Solving the optimization problem of the utility function in Equation (4) subjected to different budget constraints, we can obtain the housing demand for two housing markets.

On the supply side, the supply of residential land for local workers remains unchanged, that is, $H_{i,n}^s = \overline{L}_{r,i}$. Yet, the supply of endowed land for migrant workers equals total endowment, that is, $H_{i,m}^s = \overline{N}_i \overline{L}_o$. Then we get the equilibrium rental price of housing for migrants:

$$r_{i,m} = \sigma_m w_{i,m} M_i / \overline{N}_i \overline{L}_o, \tag{20}$$

and the rental price of housing for local workers:

$$r_{i,n} = \sigma_n \left(w_{i,n} + r_{i,m} \overline{L}_o\right) \overline{N}_i / \overline{L}_{r,i} = \sigma_n \left(w_{i,n} \overline{N}_i + \sigma_m w_{i,m} M_i\right) / \overline{L}_{r,i}. \tag{21}$$

Substituting the rental price of housing for migrant workers (20) into the spatial equilibrium condition, we have labor supply function of migrants. Labor demand remains the same as in Equation (3). Then we can solve for the equilibrium employment for migrants:

$$M_i = \varphi_{m,i}^{\frac{1}{1-\beta(1-\sigma_m)}} \left(\overline{N}_i \overline{L}_o\right)^{\frac{\sigma_m}{1-\beta(1-\sigma_m)}} \times \left(A_i \overline{L}_{f,i}^{\gamma} \overline{N}_i^{\alpha}\right)^{\frac{1-\sigma_m}{1-\beta(1-\sigma_m)}}, \tag{22}$$

where $\varphi_{m,i} = \beta \left(1-\sigma_m\right)^{1-\sigma_m} \sigma_m^{\sigma_m} \left(\beta \sigma_m\right)^{-\sigma_m} \overline{U}^{-1} \theta_i$.

Further, we can solve for the equilibrium wage of migrant and local workers as the following:

$$w_{i,m} = \beta \varphi_{m,i}^{\frac{-(1-\beta)}{1-\beta(1-\sigma_m)}} \left(\overline{N}_i \overline{L}_o\right)^{\frac{-(1-\beta)\sigma_m}{1-\beta(1-\sigma_m)}} \times \left(A_i \overline{L}_{f,i}^{\gamma} \overline{N}_i^{\alpha}\right)^{\frac{\sigma_m}{1-\beta(1-\sigma_m)}}, \tag{23}$$

$$w_{i,n} = \alpha\varphi_{m,i}^{\frac{\beta}{1-\beta(1-\sigma_m)}} \left(\overline{N}_i\overline{L}_o\right)^{\frac{\beta\sigma_m}{1-\beta(1-\sigma_m)}} \times \left(A_i\overline{L}_{f,i}^{\gamma}\overline{N}_i^{\alpha}\right)^{\frac{1}{1-\beta(1-\sigma_m)}} \overline{N}_i^{-1}, \tag{24}$$

and for the equilibrium rental price of housing for migrant and local workers:

$$r_{i,m} = \beta\sigma_m\varphi_{m,i}^{\frac{\beta}{1-\beta(1-\sigma_m)}} \left(\overline{N}_i\overline{L}_o\right)^{\frac{-(1-\beta)}{1-\beta(1-\sigma_m)}} \times \left(A_i\overline{L}_{f,i}^{\gamma}\overline{N}_i^{\alpha}\right)^{\frac{1}{1-\beta(1-\sigma_m)}}, \tag{25}$$

$$r_{i,n} = \left(\alpha\sigma_n + \beta\sigma_n\sigma_m\right)\varphi_{m,i}^{\frac{\beta}{1-\beta(1-\sigma_m)}} \left(\overline{N}_i\overline{L}_o\right)^{\frac{\beta\sigma_m}{1-\beta(1-\sigma_m)}} \times \left(A_i\overline{L}_{f,i}^{\gamma}\overline{N}_i^{\alpha}\right)^{\frac{1}{1-\beta(1-\sigma_m)}} \overline{L}_{r,i}^{-1}. \tag{26}$$

Compared with the results in the basic model, it is easy to find that residential land supply in the extensive model no longer has effect on the population of migrants or the wage of two types of workers or the housing cost for the migrant workers, which we summarize as Proposition 4:

PROPOSITION 4. *When migrant workers live on the land leased by local residents, residential land supply only affects the housing price for local residents, and has no effect on workers' migration or wage of both types of workers or the housing cost of migrants, that is,* $\partial M_i/\partial\overline{L}_{r,i} = \partial w_{i,m}/\partial\overline{L}_{r,i} = \partial w_{i,n}/\partial\overline{L}_{r,i} = \partial r_{i,m}/\partial\overline{L}_{r,i} = 0$, *and* $\partial r_{i,n}/\partial\overline{L}_{r,i} < 0$.

What is the implication of Proposition 4? When local governments decide to supply less residential land for citizens, it would only push up housing price related to residential land, but would not stop migrants from moving into these cities, or have any negative effect on economic growth. Residential land supply has no equilibrium impact on the wages of both migrant and local workers.

IV. EMPIRICAL RESULTS

In this section, we first construct an empirical measure of government intervention based on the price difference between residential and industrial land. Exploring the spatial variation in the price difference, we investigate how government intervention affects the relationships between exogenous productivity shocks and the changes in population, wage, and housing price, using data from Chinese cities between 2000 and 2010.

A. *Government Intervention*

Our measure of government intervention relies on the price difference between residential and industrial land. We construct a dummy variable for government intervention that separates the sample into two groups with high or low intervention, in order to alleviate the reliance on the absolute value of land prices. We rank all the cities according to the price ratio between residential and industrial land. The cities in the top 30th percentile are classified as those with high government intervention. We also use other percentiles (20th, 40th, or 50th) to define the dummy variable, but find no significant difference in the results.

To identify the effect of government intervention on urban development, we rely on the spatial *difference in the differences* between residential and industrial land price. We believe that the prices for different land uses should differ due to their location, quality, and length of use right, but such a difference should be in a reasonable range, after we control for the impact of public goods, reserved utility, city, and time fixed effects. Our measure of government intervention, by its construction, only captures the relatively large difference in the price of residential and industrial land.

The difference in government intervention across cities is not the same as the difference in demand shocks for residential and commercial land. The cities with high government intervention are not all in east China where the demand for housing is higher than the rest of the country. Moreover, high government intervention can reflect both a high price of residential land and a lower price of industrial land, as seen from the summary statistics in Table 4. The relative standard deviation of the residential land price is just slightly higher than the standard deviation of the industrial land price.

There is a salient time trend in the change of the price ratio between residential and industrial land. In the period from 2003 to 2005, the median difference has an increasing trend, but decreased in the period from 2006 to 2008. Such a pattern is related to the macroeconomic change and government regulation. In the first period, the central government encouraged investment and growth, but economic policies changed in the second period because of the fear of a housing bubble.

TABLE 4
Summary Statistics of Negotiated and Market-Based Land Sale: Price, Area, and Revenue

	Market-Based Sale Price (Million Yuan/Hectare)			Negotiated Sale Price (Million Yuan/Hectare)			Intervention Measure (Market-Based/Negotiated)		
	Mean	**Median**	***SD***	**Mean**	**Median**	***SD***	**Mean**	**Median**	***SD***
Nation	6.00	4.19	6.80	1.63	1.27	1.48	5.33	3.48	9.40
Low intervention	4.44	3.71	3.15	1.76	1.36	1.52	3.26	2.72	2.38
High intervention	9.62	6.21	10.57	1.34	1.00	1.35	10.20	6.76	15.79
	Market-Based Sale Area (1,000 Hectare)			**Negotiated Sale Area (1,000 Hectare)**			**Share of Market-Based Sale (%)**		
	Mean	**Median**	***SD***	**Mean**	**Median**	***SD***	**Mean**	**Median**	***SD***
Nation	280	145	397	409	152	705	47	42	27
Low intervention	247	140	351	310	132	533	49	45	27
High intervention	354	159	480	642	237	959	42	35	27
	Market-Based Sale Revenue (Billion Yuan/Hectare)			**Negotiated Sale Revenue (Billion Yuan/Hectare)**			**Share of Market-Based Sale (%)**		
	Mean	**Median**	***SD***	**Mean**	**Median**	***SD***	**Mean**	**Median**	***SD***
Nation	2,153	558	4,975	741	184	2,146	70	75	22
Low intervention	1,373	471	3,244	646	177	2,299	67	71	23
High intervention	3,958	1,029	7,289	964	204	1,715	77	81	19

Compared to cities with low government intervention, cities with high intervention sell a smaller share of residential land through market mechanisms (42% vs. 47%) that accounts for a much larger share of their revenue (77% vs. 67%). This suggests some strategic manipulation in the land market, especially among cities with high government intervention. The pursuit of economic growth drives down the price of industrial land because of the competition for industrial investment and the pursuit for fiscal revenue drives up the price of residential land. In sum, our measure of government intervention is more of a consequence of the land market institution and China's political economy.

Figure 7 demonstrates the differences in the relationship between productivity shocks and urban dynamics for cities with high or low government intervention. Specifically, it describes the impact of positive productivity shocks on the changes in population, housing price, and wage. We approximate exogenous productivity shocks using the accumulated foreign direct investment (FDI) at the initial year of each period. It shows a positive relationship between productivity shock and the changes in population, housing price, and wage. The impact of productivity is relatively higher among the cities in the east compared to those in the middle and in the west of China. In places with high government intervention, housing price and population increase more than those in the places with low intervention; such a difference is less salient in the case of wage change. We also use human capital stock (measured by the total years of schooling at the initial year of each period) as an alternative measure of productivity and the relationships are similar.

B. Empirical Findings

The empirical specification follows the approach in Glaeser, Gyourko, and Saks (2006) who investigate how housing supply constraint affects urban dynamics using data from the metropolitan areas in the United States. Assuming that the productivity shocks are exogenous and let $A_{j,t+1} - A_{j,t} = \beta_A x^A_{j,t} + \varepsilon^A_{j,t}$, we can write down the estimation equations as follows:

$$(27)\quad y_{j,t+1} - y_{j,t} = \alpha^y + \beta^y_A x^A_{j,t} + \beta^y_I I_{j,t} + \beta^y \left(x^A_{j,t} I_{j,t}\right) + x_{j,t}\gamma^y + \varepsilon^y_{j,t}.$$

The dependent variables $y_{t+1} - y_t$ in the regressions are the 5-year changes in residential population (lnN), wages (w), and housing prices (p_h) from 2000 to 2005 and from 2005 to 2010. In the estimation on population, we take the logarithm because of the much larger variation in population change, as seen in Table 2.

We employ human capital stock (total years of schooling) and accumulated FDI in the initial year as the proxies for exogenous productivity

FIGURE 7

Government Intervention and Changes in Population (dlnn), Wage (dW), and Housing Price (dP)

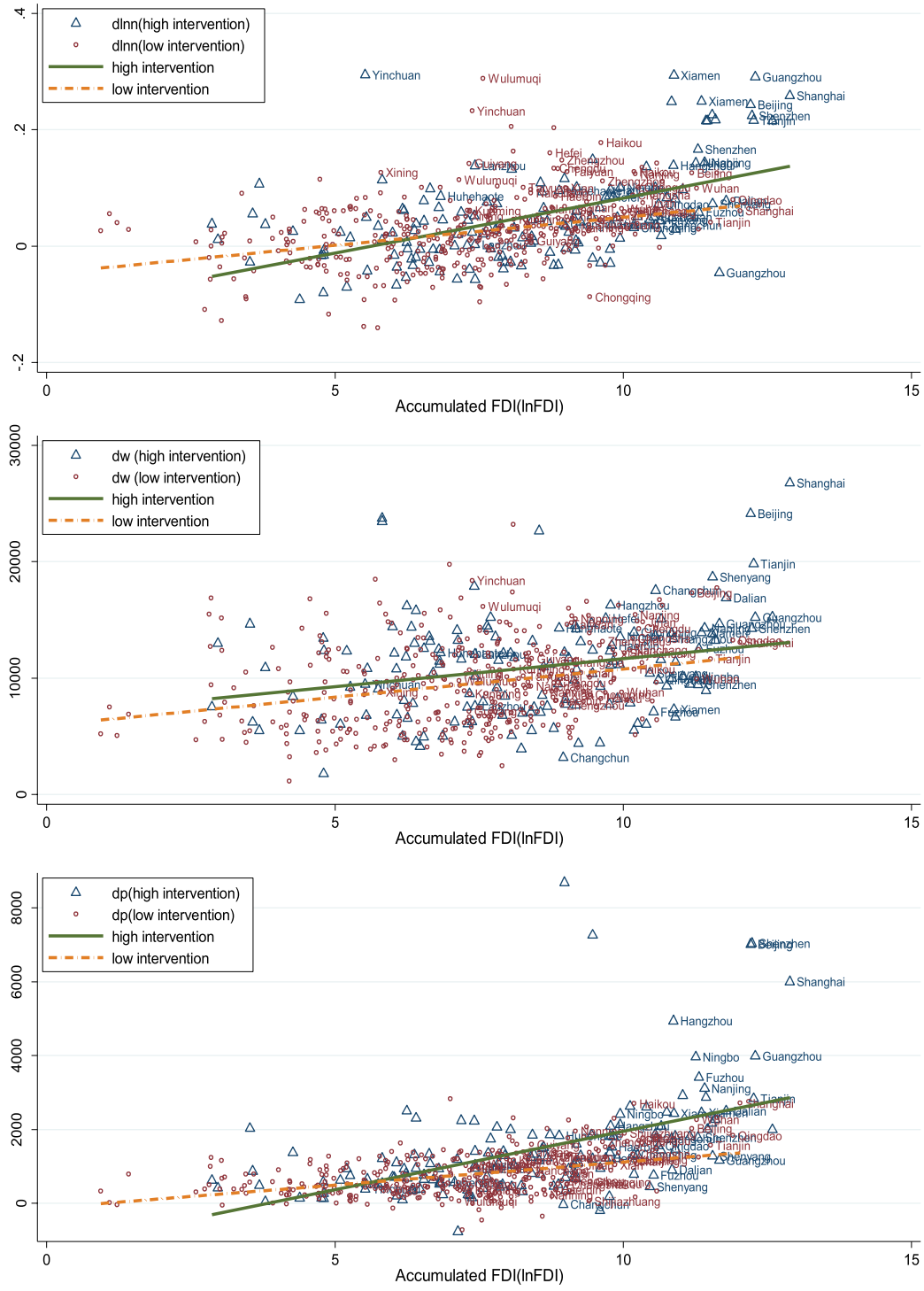


TABLE 5
Estimation Results: Pooled OLS

	ln(Population) Change	Wage Change	Housing Price Change	ln(Population) Change	Wage Change	Housing Price Change
Human capital	.0242***	736.5***	74.15*			
	(.0087)	(250.7)	(40.05)			
Human capital*	.0164	112.5	337.5**			
Intervention dummy	(.0097)	(370.9)	(140.5)			
ln(FDI)				.0098***	242**	87.27***
				(.002)	(109.1)	(15.7)
ln(FDI)*				.0099***	2.437	200.8***
Intervention dummy				(.003)	(157.7)	(35.24)
Time dummy	−.0108	4,954***	733.2***	−.0158*	4,483***	538.9***
	(.0095)	(544.1)	(82.96)	(.0088)	(439)	(63.09)
Intervention dummy	−.116	39.91	−2,273*	−.0639**	1,026	−1,130***
	(.0793)	(3,433)	(1,208)	(.0262)	(1,424)	(309.4)
Constant	−.1788**	849.4	−216	−.0411**	5,431***	−131.2
	(.0748)	(1,976)	(319.7)	(.0169)	(787.3)	(110.3)
Observations	486	468	485	512	511	511
R^2	.25	.46	.34	.25	.41	.40
F-statistics	10.26	26.25	24.36	12.84	32.51	32.55

Note: Clustered standard errors are in parentheses.
Significance levels: *10%, **5%, ***1%.

shocks, x^A. These two productivity measures are used commonly in the study of Chinese economy and are proved to be good proxies (Au and Henderson 2006). Our focus is the estimate (β^y) before the interaction item between productivity measure and the dummy variable for high government intervention, *I*. *x* is a set of control variables, including city and time fixed effects, a set of public goods measures, and the urban-rural income gap as a proxy for reserved utility.

Table 5 shows the results from pooled ordinary least squares (OLS) regression without additional control variables for fixed effects and time-varying regional factors. The first three columns show the results using human capital stock at the initial year as the proxy for productivity shock; the last three columns show the results using accumulated FDI as productivity measure. The first row contains the estimated impact of human capital on the changes in population, housing price, and wage for the prefectures with low government intervention, and the second row contains the estimated impact for the prefectures with high intervention.

The most salient finding in Table 5 is that the impact of positive productivity shocks on the increase of housing price for the cities with high government intervention (338 and 201 Yuan/m^2 for human capital and FDI measure, respectively) is significantly larger than the impact for the cities with low intervention (74 and 87 Yuan/m^2). The estimated coefficients vary between 74 and 338, which imply that one unit of increase in productivity leads to an increase in housing price by 74–338 Yuan/m^2, a large effect economically. This finding confirms our conjecture that government intervention in the land market is an important determining factor for housing price appreciation. These results are robust in most empirical specifications, as discussed later in the section on robustness analysis.

The impact of government intervention on housing prices comes from two channels: one is through lower supply of residential land and hence less supply of housing services; the other is through more supply and thus lower price of industrial land that generates higher demand for workers and housing services. In China's housing market, the first channel might be more important than the second channel, because government control over residential land supply is more influential than the limited housing demand from migrants.

The housing demand of migrant workers is best captured by the specification in Section III.E. Most migrant workers live in a factory dorm, urban village, or share a tiny apartment with peers. In a survey (Tao 2011) conducted in the Pearl River Delta that attracts huge amount of migrant workers, about 50% of the workers are living in factory dorms and another 40% are living in an "urban village" that serves cheap housing. An urban village appears during the rapid expansion of a city and is developed using

collective-owned land under the control of local authorities, see Song and Zenou (2012) for an example. Most of the housing is rented to migrant workers. According to Shi (2010), the urban villages in Shanghai are crowded, unsafe, and lack public facilities; most residents are migrant workers who work in the nearby factories and earn low income.

In contrast to the evidence from the United States, we find no significant evidence that high government intervention in land market constrains population increase and leads to larger increase in wage, compared to those cities with lower government intervention. As shown in Table 5, for the cities with high government intervention, the estimated impact of productivity on population change is either positive or not significant, and the estimated impact on wage change is positive but not significant. Productivity shocks, however, do have positive impact on the population and wage increase in the cities with low government intervention.

Theoretically, the impact of government intervention on the relationship between population changes and positive productivity shocks is not deterministic. We expect that the effect of lower industrial land price on firms' demand for more workers is larger than the effect of higher housing cost (from lower residential land supply) on the supply of labor, because migrant workers care more for a job than housing services. Hence, higher government intervention might lead to more population increase.

The stylized facts of China's urban development documented in Section II can explain why positive productivity shocks have no significantly positive impact on wage change in the cities with high government intervention in the land market. Migrant workers are one of the major forces behind the economic success of Chinese cities. The wage of migrant workers, however, is relatively low because of the large supply of migrant workers in most cities. On one hand, lower industrial land price leads to higher demand for labor, but firms need not pay higher wage in order to hire workers; on the other hand, less residential land supply should drive up wage because of higher living cost, but the limited housing demand of migrant workers alleviates this effect. In the terminology of the model, these factors can be captured by the reserved utility $\bar{U}$ that might be low for migrant workers or negatively correlated with productivity shock and thus wage.

The time fixed effect is a very important factor in explaining the increases in housing price and wage, which means that period-specific factors, such as macroeconomic shocks and government policy changes, have significant contributions to the increase of housing price and wage.

Interestingly, the intervention dummy has a significant negative impact on the change of housing price, which means that the place with high government intervention on average has less housing price increase, after controlling for the impact of productivity and other explanatory variables. This suggests that the measure of government intervention is less likely to be correlated with the unobserved demand shocks that should have positive impact on housing price increase. Hence, the endogeneity problem caused by demand shocks might not be a big problem after controlling for productivity shocks and time fixed effects.

C. Robustness Analysis

We run the following robustness checks: adding more control variables, considering fixed effects, using instrumental variables, and choosing alternative measures of productivity and government intervention.

Tables 6 and 7 report the results from the regressions with additional control variables and fixed effects. The estimated effects of productivity shocks on the change of population, housing price, and wage are not significantly different from the results in the baseline pooled OLS estimation, for the cities with high government intervention. But, some estimates for the cities with low government intervention become insignificant. Most public goods measures have significant positive impact on the change of population, wage, and housing price. These findings are intuitive because cities with better public goods attract more people and lead to increases in housing price and wage. Most of the estimates for the interaction items between regional dummy and productivity are not significant.

There is the concern that the measure of government intervention might be endogenous due to time-varying city-specific unobserved demand shocks that affect both the land price ratio and the change of population, wage, and housing price. An indirect test on the endogeneity problem is to run regression using instrumental variables that can explain the government control over land market but are not likely correlated with unobserved demand shocks. A potential choice of such instruments is geographic characteristics of Chinese prefectures. Specifically, we explore the

TABLE 6
Estimation Results: Pooled OLS with Controls

	ln(Population) Change	Wage Change	Housing Price Change	ln(Population) Change	Wage Change	Housing Price Change
Human capital	.0093	434	51.94			
	(.0122)	(496.5)	(190.1)			
Human capital*	.0122	−297.7	244.5**			
Intervention dummy	(.0086)	(405.8)	(89.59)			
Human capital*	.0158	−573.7	−180.8			
West dummy	(.0152)	(475.9)	(195)			
Human capital*	.0022	−867.5	−287.1			
Middle dummy	(.0137)	(634.7)	(190.5)			
ln(FDI)				.0178***	182.4	128.2
				(.0042)	(401.2)	(82.32)
ln(FDI)*				.0049	−139.4	138.9***
Intervention dummy				(.0029)	(103.1)	(36.84)
ln(FDI)*				−.0137***	−226.7	−135.5*
West dummy				(.0046)	(398.9)	(76.13)
ln(FDI)*				−.0155***	−213.9	−136.1*
Middle dummy				(.0043)	(453.7)	(77.58)
Income gap	.0339*	−256.8	−148	.0336**	−137	−157.3
	(.017)	(883.5)	(182)	(.0135)	(842.5)	(139.2)
Library resources	.0187**	1,247***	370***	.0082	988.5***	237.8**
	(.0074)	(313.6)	(119)	(.0071)	(351.6)	(105.5)
Hospital bed	.0013**	65.47**	3.989	.002***	70.45***	7.882
	(5.5e-04)	(24.06)	(7.108)	(5.0e-04)	(17.4)	(5.896)
Constant	−.1446	2,594	299.2	−.2213***	4,712	−314.9
	(.1001)	(3,863)	(1,890)	(.0502)	(3,890)	(1,040)
R^2	.39	.53	.45	.43	.49	.47
F-statistics	16.76	33.35	15.16	20.24	33.86	27.16

Notes: Region, time, and intervention dummies are included. Clustered standard errors are in parentheses. The number of observations is the same as that in Table 5.
Significance levels: *10%, **5%, ***1%.

composition of different land types within a prefecture. If a local government has limited land resource to develop for either industrial or residential use, it will have limited monopoly power and less control over the land market. Such geographic characteristics are largely determined by exogenous natural endowment and have little to do with the contemporary demand shocks.

In the generalized method of moments (GMM) estimation, the instruments we used are the shares of four types of land in total land area in a prefecture: water, mountain and forest, cultivated land, and undeveloped land. The results of GMM estimation are shown in Table 8. In general, the findings are largely consistent with our conclusions from the pooled OLS and fixed effects models. The most salient different finding is that the effect of high government intervention on wage increase is significant and positive, as the theory predicts. The first-stage estimation, however, shows that these instruments are weak and the *F*-statistics are between 5.7 and 8.5. Hence, we still use the pooled OLS and fixed effect models as the benchmark results, rather than the GMM estimation.

The endogeneity problem in our application might be alleviated by the construction of government intervention whose variation among cities relies on the spatial difference in the price differences, instead of the absolute price level. The price difference represents more of the government control over land use and supply. In the summary statistics, the cities with high government intervention are quite different from the cities that we think are more likely facing high demand shocks. The negative impact of the government intervention dummy on the change of housing price also suggests an insignificant correlation between government intervention and unobserved demand shocks. This is further supported by the fact that there is no significant difference between the regression results from the models with and without controlling for public goods measures and city fixed effects, when comparing Tables 5–7.

Lastly, we constructed an alternative measure of government intervention by directly deleting the impact of some demand shocks and geographical constraints on the price ratio. Firstly, we run a regression using the price ratio

TABLE 7
Estimation Results: Fixed Effects with Controls

	ln(Population) Change	Wage Change	Housing Price Change	ln(Population) Change	Wage Change	Housing Price Change
Human capital	.0585**	−1,430	180			
	(.0266)	(1,828)	(223.3)			
Human capital*	.0153	521.8	300.5*			
Intervention dummy	(.013)	(733.4)	(152.3)			
Human capital*	−.0545	4,820	−714.5*			
West dummy	(.0533)	(3,590)	(405.9)			
Human capital*	−.0617*	2,104	−699.1**			
Middle dummy	(.0337)	(1,988)	(293.7)			
ln(FDI)				.0112	−1,060	−49.29
				(.009)	(880.7)	(139.1)
ln(FDI) *				.0068*	391.7	49.72**
Intervention dummy				(.0038)	(289.3)	(18.69)
ln(FDI)*				−.0363***	1,489	−173.5
West dummy				(.0063)	(963.1)	(131.5)
ln(FDI*				−.0103	554.8	−161.9
Middle dummy				(.0122)	(818.6)	(113.6)
Income gap	−.0749	−148.9	−83.64	−.0821**	1,262	−504.9*
	(.0662)	(1,373)	(316.4)	(.0308)	(1,529)	(287.1)
Library resources	.0238*	−256.8	160	.0098	−202.8	55.2
	(.013)	(346.6)	(277.9)	(.0117)	(573.5)	(196.3)
Hospital bed	.0034*	−218.9***	10.02	.0028*	−194.3**	8.433
	(.0017)	(75.21)	(15.57)	(.0014)	(76.31)	(15.84)
Constant	−.0482	7,854	2,260	.1938	1.1e + 04**	2,572**
	(.1929)	(1.0e + 04)	(1,419)	(.1148)	(5,105)	(991.1)
R^2	.24	.69	.46	.25	.69	.45
F-statistics	4.728	53.79	18.98	8.63	37.28	23.87

Notes: Intervention and time dummies included. Clustered standard errors in parentheses. The number of observations is the same as that in Table 5. Fixed effects are city specific.
Significance: *10%, **5%, ***1%.

as the dependent variable, and the independent variables are GDP—a proxy for demand shock—and the proportion of land available for development—a proxy for geographic constraint of land supply. Then, we use the residuals from this regression as an intervention measure. We find that the exogenous productivity shocks have positive effects on the change of population, housing price, and wage for the cities with low government intervention, but the estimates for the cities with high government intervention are either smaller or insignificant. The smaller effect of productivity shock on housing price for the places with high land market distortion is different from the findings in other specifications. This highlights the potential problem with omitted demand shocks, but our other conclusions stand with this measure of land market distortion.

V. CONCLUSIONS

In this article, we document the stylized facts of China's urban development and land market between 2000 and 2010, by collecting data from Chinese cities through various sources. In order to better understand China's urban dynamics and its relationship with government intervention in the land market, we develop a spatial equilibrium model that incorporates the special institutional features of China's land market. Theoretically, the heterogeneity of housing demand from migrant workers plays a key role in explaining the stylized facts of China's urban development. In terms of empirical relevance, we think the best specification of housing market is a case where migrant workers have zero housing demand.

Empirically, we find that high government intervention enlarges the impact of positive productivity shock on the increase of housing price, but does not constrain population growth and leads to wage increase. Our interpretation lies in China's land market institution and local political economy, including the competition for investment and fiscal revenue among local governments, which leads to the constraints on wage increase and housing demand of migrant workers.

We think that China's rapid urbanization is "incomplete," in the sense that migrant workers are not well compensated, have limited housing consumption and restricted access to public services. From the policy perspective, China

TABLE 8
Instrumental Variable Estimation Results (GMM)

	ln(Population) Change	Wage Change	Housing Price Change	ln(Population) Change	Wage Change	Housing Price Change
Human capital	−.02208	−3,354.7*	−304.91			
	(.0272)	(1,785)	(377.6)			
Human capital*	.06753**	5,409.2**	949.3***			
Intervention dummy	(.0339)	(2,333)	(344.8)			
Human capital*	.02777	1,396.9	37.648			
West dummy	(.022)	(1,337)	(343.7)			
Human capital*	.01237	1,058	−95.233			
Middle dummy	(.0202)	(1,281)	(301.8)			
ln(FDI)				.02114*	767.37	130.54
				(.0119)	(543.6)	(150)
ln(FDI)*				−.00172	−155.54	216.99
Intervention dummy				(.0151)	(900.9)	(202.3)
ln(FDI)*				−.01903*	−841.27	−121.71
West dummy				(.0113)	(550.9)	(142.2)
ln(FDI)*				−.01566*	−1,030.5*	−122.92
Middle dummy				(.0084)	(562.3)	(119.5)
Income gap	.02323	361	−115.33	.02064	−110.36	−72.141
	(.015)	(1,347)	(129.4)	(.0154)	(619.3)	(63.78)
Library resources	.01302*	1,245.8***	238.94***	.0058	1,066.8**	138.59
	(.0069)	(282.7)	(67.61)	(.0064)	(463.9)	(88.76)
Hospital bed	.00184***	96.997***	5.7792	.00248***	81.823***	9.2266
	(4.2e-04)	(27.17)	(5.274)	(4.3e-04)	(20.99)	(5.621)
Constant	.13576	35,275**	3,231.5	−.23352**	2,253.7	−295.95
	(.2382)	(1.4e + 04)	(3,218)	(.0998)	(4,096)	(1,070)
Chi-square	265.87	720.57	615.8	241.68	530.4	345.34

Notes: Intervention, region, and time dummies included. Clustered standard errors in parentheses. Observations are the same as those in Table 5.
Significance: *10%, **5%, ***1%.

needs to change the way in developing local economies and improve the living environment for its people, especially migrant workers. Integrating migrant workers into urban society is crucial for both economic sustainability and social stability. Central government should also adopt systematic reform measures to improve the allocation efficiency of land resources.

Finally, we acknowledge some limitations of our study. The data on land sale are not perfect. Both the prices of industrial and commercial land might be affected by corruption, as demonstrated by Cai, Henderson, and Zhang (2010). Our measure of government intervention is better understood as an aggregate statistics and is more meaningful for cross-city comparison.

Moreover, land supply as the key decisions of local governments is not modeled in the article. Thus, it is unclear how land supply is affected by other variables of China's local political economy. In future research, it seems important to estimate a structural model of government behavior for a better evaluation of policy changes and their impact on welfare. Meanwhile, the problems in China's land and housing markets can be better understood by utilizing more detailed land market data. More information on migrant workers can also provide valuable knowledge on China's city development.

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