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DIRECT GOVERNMENT CONTROL OVER RESIDENTIAL LAND SUPPLY AND ITS IMPACT ON REAL ESTATE MARKET:

EVIDENCE FROM MAJOR CHINESE MARKETS

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ABSTRACT

In the early and mid-2000s, the development of land reserve system promoted a structural change in residential land market in urban China, and the municipal government has become the sole supplier of urban residential land after the structural change. This paper examines the impact that direct government control over residential land supply has on real estate markets in major Chinese cities. It is found that there is a significant decrease in land supply after the establishment of direct government control over residential land supply, and the decrease in land supply has put downward pressure on new housing supply. It is also found that there is a decline in the price elasticity of new housing supply in the period characterized by more restrictive land supply.

Keywords: government monopoly on land supply, new housing supply, housing supply elasticity, urban China

1. INTRODUCTION

Government intervention in land market exists in countries with different land use systems. This intervention generally takes two forms. The first involves various types of land use regulation (such as zoning, urban growth boundaries, master planning, etc.) that imposes control over the uses to which a piece of land can be put. The second involves direct government control over land supply (government acting as a market participant and directly supplying land to the land users). Government intervention in land market can have profound impacts on real estate market. One impact is that it can reduce the amount of land available for housing development, and in turn, depress new residential construction and push up housing prices in the presence of high demand for housing (Cheshire & Sheppard 2004, 2005; Dawkins & Nelson 2002; Monk & Whitehead 1999; Peng & Wheaton 1994; Saiz 2010). While many empirical studies have examined the impact of land use regulation on land availability, new housing supply and housing price, relatively little attention has been devoted to the impacts that direct government control over land supply might have on real estate market.

China's urban housing sector has experienced a tremendous growth since 1998, when the market-oriented housing system was established in China. There has been a surge in real estate investment, from 361.42 billion yuan in 1998 to 6179.69 billion yuan in 2011 (National Bureau of Statistics of China). There has also been a pronounced boom in housing price, with average housing price increasing from 1854 yuan per square meter in 1998 to 4993 yuan per square meter in 2011 (National Bureau of Statistics of China). The fast-growing emerging real estate market in urban China has attracted increasing research attention worldwide. However, relatively little attention has been devoted to an important structural change of residential land market which occurred in the mid-2000s, i.e., the establishment of direct government control over residential land supply. This structural change provides a unique opportunity to investigate the impacts that direct government control over residential land supply has on real estate market.

This study examines the impacts that direct government control over residential land supply has on China's real estate market, using the data for 18 major Chinese cities for the period 2000-2011. The empirical analysis is conducted in two stages. In the first stage, the process that leads to the establishment of government control on residential land supply is investigated, and the change in residential land supply before and after the establishment of government control on residential land supply is examined. In the second stage, the econometric models of new housing is developed and estimated. The aim is to examine whether the decrease in land supply after the structural change in residential land market has put downward pressure on new housing supply, and weather there is a decrease in the price elasticity of new housing supply after the establishment of government monopoly on residential land supply.

The rest of the paper is structured as follows. The next section reviews the pertinent literature, and section 3 provides an overview of the real estate markets in the 18 cities. Section 4 then turns to analyse the establishment of direct government control over residential land supply and its impact on land supply. This is followed by section 5 with an analysis of the impact that decline in land supply has on new housing supply and housing price elasticity, and conclusion brings the paper to a close.

2. LITERATURE REVIEW

There are broadly three strands of literature that are related to this research. The first set of papers focus on the impact that government intervention in land market has on land supply. The second strand of literature involves the empirical studies on housing supply, and the third strand of literature consists of papers on the impact of land supply on new housing supply.

Governments around the world use land use regulation to manage the development of land and prevent land use conflicts. One of the primary consequences of land use regulation is that the supply of land for a specific use (including residential land supply) can be reduced below the level which would have occurred in the un-intervened market (DiPasquale & Wheaton 1996). The Government can impose more direct control over land development and land supply by acting as a land supplier, and this type of government intervention can also result in a relative scarcity of residential land. Kim (1993) finds that, the amount of urban residential land increased at a speed much lower than the rate of urban population growth between 1970s and 1980s in Korea, leading to an extraordinarily rapid rise in land and housing prices. He argues that, since the public sectors played a predominant role in land development and land supply in Korea, the government could impose strict control on the quantity and location of the land available for housing development, which made residential land supply less responsive to the change in the demand. Hannah, Kim and Mills (1993) argue that, the Korean government tended to under-allocate land to urban residential use during the 1970s and 1980s so that they could obtain higher revenue from land sales to finance infrastructure investment and provide subsidised housing. Bertaud (2012) also suggests that, when the government is the sole supplier of land, it might undersupply land in order to keep land price high and maximize the profit from land sales.

There has been a growing body of literature devoted to the analysis of the supply of housing in the last three decades. As suggested by Ball, Meen and Nygaard (2010), there is a consensus that the factors affecting new housing supply mainly include housing price and the cost of housing production (Ball, Meen & Nygaard 2010; Blackley 1999; Dipasquale & Wheaton 1994; Gitelman & Otto 2012; Grimes & Aitken 2010; Hwang & Quigley 2006; Mayer & Somerville 2000b; Poterba 1984; Topel & Rosen 1988), land supply (Bramley 1993; Peng & Wheaton 1994; Pryce 1999), planning controls (Green, Malpezzi & Mayo 2005; Mayer & Somerville 2000a; Mayo & Sheppard 1996) and climate conditions (Cammarota 1989; Coulson & Richard 1996; Fergus 1999; Goodman 1987). Since any housing unit has to be built on a parcel of land, given a certain building density, land supply has a positive impact on new housing supply. Another explanation for the positive relationship between land supply and new housing supply is that the shortage of residential land can drive up land price and the cost of housing production, which in turn puts downward pressure on new housing supply. Bramley (1993) and Pryce (1999) examine the effect of land supply on new residential construction by estimating cross-sectional models of new housing supply. Bramley finds that land supply has a significantly positive impact on new housing supply. Pryce finds that the elasticity of new housing supply with respect to land supply is slightly greater in the housing boom than in the housing bust. Peng and Wheaton (1994) examine the impact of land supply on new housing supply and housing price in Hong Kong. They find that land supply has no bearing on new housing supply but has a significantly negative impact on housing price. They argue that, due to Hong Kong's flexible restriction on housing density and the existence of speculative land hoarding, housing production is not curtailed by more restrictive land supply. They also suggest that, decreased land supply is taken as a sign of more restrictive land supply in the long run, which in turn will drive up the anticipated future housing rents. In a rational market, the expectation of higher future housing rents will be capitalized into higher current housing prices. It is noteworthy that, not only the steady-state level of new residential construction, but also the responsiveness of new housing supply to the change in housing price (i.e. the housing supply elasticity) can be influenced by land supply. Saiz (2010) develops a theoretical model to explore the determinants of housing supply elasticity, the model shows that housing supply elasticity is increasing in land availability. In the empirical work, he estimates the city-specific housing supply elasticities for US metropolitan areas, and finds that geographical land constraints play a crucial role in accounting for the intercity differences of supply elasticities.

Many studies have examined the factors affecting new housing supply and estimated the price elasticity of housing supply by estimating the econometric models of housing supply. However, there is less consensus regarding the appropriate specification of the models of housing supply (Ball, Meen & Nygaard 2010; Harter-Dreiman 2004; Hwang & Quigley 2006). In 1980s, two widely cited studies (Poterba 1984; Topel & Rosen 1988) applies Tobin's q theory of investment (Tobin 1969) to modelling housing supply. The q theory implies that, the decision to produce new housing units is based on the expected profitability of the housing projection, and new housing units will be built only when q (the ratio of housing prices to the cost of housing production) is greater than 1. Thus housing supply is specified as a function of the levels of housing prices and cost variables in the two studies. Dipasquale and Wheaton (1994) and Mayer and Somerville (2000b) suggest that, the investment-based models developed by Poterba and Topel and Rosen do not take into account the role of land as an essential input in housing production. Since land is distinct from other factors of production, treating residential construction like other types of investment can be problematic. Dipasquale and Wheaton (1994) suggest that, according to the urban spatial theory, an increase in housing price leads to a

temporary increase in residential construction rather than a permanent one, thus specifying housing starts as a function of housing price levels can be problematic. They argue that, following a positive demand shock, although increased housing price will initially generate excess return and bring about higher level of new construction, since land price will rise significantly with the increase in the size of housing stock, the marginal costs of housing production would eventually equal housing price, resulting in new construction returning to its normal level. Thus housing starts respond to a growth in housing price only temporarily, until the existing housing stock adjusts to the long-run equilibrium level. Mayer and Somerville (2000b) formally derive the relationship between housing starts and the changes in housing prices and construction costs from the Capozza-Helsley urban growth model (Capozza & Helsley 1989). In this model, housing price at an interior location of a city is regarded as the sum of agricultural land price, structure costs, the present value of location rent and the present value of the expected increase in house rent. After a simple derivation, the distance from the city centre to the border (which is an index of the city size) can be expressed as a function of the levels of housing prices and construction costs. Housing stock, which is another index of city size, can also be taken as a function of the levels of housing prices and construction costs. Housing starts, which is equal to the changes in the stock of housing units when ignoring abandonment and demolition, then can be expressed as a function of the changes in housing prices and construction costs. Following Mayer and Somerville (2000b), many studies have used the *changes* approach to modelling new housing supply in recent years (Ball, Meen & Nygaard 2010; Hwang & Quigley 2006; McLaughlin 2012; Meen & Nygaard 2011; Zabel & Paterson 2006).

3. OVERVIEW OF THE MARKETS IN THE 18 CITIES

This study mainly examines the housing markets in 18 major Chinese cities. The 18 cities include 3 province-level municipalities (Beijing, Shanghai and Tianjin), 11 provincial capitals (Guangzhou, Nanjing, Hangzhou, Jinan, Wuhan, Hefei, Fuzhou, Changsha, Xian, Chengdu and Nanchang, which are the capitals of Guangdong province, Jiangsu province, Zhejiang province, Shandong province, Hubei Province, Anhui Province, Fujian province, Hunan province, Shanxi province, Sichuan province and Jiangxi province, respectively) and 4 sub-provincial cities (Qingdao, Ningbo, Xiamen and Shenzhen)[1]. There are mainly two reasons for choosing those cities as sample cities. First, those cities are among the most populous cities in China and are also among the most important cities in terms of economic activities. None of those cities had a population less than 1 million people in 2011, and 29% per cent of China's gross domestic product (GDP) was generated in those cities in 2011. Secondly, housing markets of those cities are among the most important markets in terms of transaction volume and total value of new home sales. In 2011, those cities accounted for 17.9% and 31.6% of the nation's transaction volume and total value of new home sales, respectively.

As a result of rapid growth of urban population and personal income, all the 18 cities were facing a high demand for housing between 2000 and 2011. As shown in table 1, the percentage increase in urban population for the period 2000-2011 was greater than 20% in 16 cities, with the most considerable increase took place in Shenzhen, Xiamen and Hangzhou (percentage increase in the 3 cities were 179.0%, 125.8% and 121.1%, respectively). Even more remarkable was the growth in personal income. None of the 18 cities has an income growth rate lower than 35% for the period 2000-2011, and the income growth rate exceeded 100% in 16 cities (Beijing, Tianjin, Shanghai, Nanjing, Hangzhou, Ningbo, Hefei, Xiamen, Fuzhou, Nanchang, Jinan, Qingdao, Wuhan, Changsha, Chengdu and Xian). Partly due to the high demand for housing, there has been a noticeable housing price appreciation in the 18 cities over the same time period. The percentage increase in housing prices (in real terms) was higher than 60% in 15 cities (Beijing, Tianjin, Shanghai, Nanjing, Hangzhou, Ningbo, Xiamen, Nanchang, Jinan, Qingdao, Wuhan, Changsha, Shenzhen, Chengdu and Xian) and exceeded 100% in 3 cities (Shanghai, Ningbo, Qingdao).

4. STRUCTURAL CHANGE IN RESIDENTIAL LAND MARKET AND ITS IMPACT ON LAND SUPPLY

4.1 China's Land System

According to *Land Use Classification* issued by China's General Administration of Quality Supervision, Inspection and Quarantine and China's Standardization Administration, land use is divided into 12 categories in mainland China, which are cultivated land, garden land, forest land, grassland, commercial land, industrial and warehousing land, residential land, land used for public administration and public services, land used for special purposes (military facilities, embassies and consulates, prisons and watch houses, religious purposes, and funeral and interment), transportation land, bodies of water and land used for water-resource facilities, and other land uses. Land ownership is divided into two categories: state land ownership and collective land ownership. Urban land (mainly including land that is located in urban areas and used for commercial purpose, industrial and warehousing purpose, residential purpose, public administration, public services, transportation and special purposes) is owned by the state, and rural land (mainly including agricultural land located in rural areas) is owned by the rural collective economic organizations. Land use rights (LURs), which means the right of using a parcel of land (subject to the regulatory constraints) for a certain time

period, is separated from land ownership, and only LURs but not land ownership is tradable. Urban development has to be conducted on the state-owned urban land, and rural land is not allowed to be used for urban development. The conversion of agricultural land to urban purposes is controlled by the government through land expropriation.

Table 1 Growth in population, personal income and housing prices in 18 major Chinese cities for the period 2000-2011

	2000 Population (1000s)	2011 Population (10,000s)	% Change, 2000-2011	2000 Income (yuan)	2011 Income (yuan)	% Change, 2000-2011	2000 Average housing price (yuan/m^2)	2011 Average housing price (yuan/m^2)	% Change, 2000-2011
Beijing	7268.8	9875	35.9	10350	25847	149.7	8845	15518	75.5
Tianjin	4990.1	5783.7	15.9	8141	21148	159.8	4735	8548	80.5
Shanghai	9382.1	12401.8	32.2	11718	28460	142.9	6567	13566	106.6
Nanjing	2558.6	5144.9	101.1	8233	25295	207.2	4670	8415	80.2
Hangzhou	1436.9	3176.3	121.1	9668	26760	176.8	6408	12749	99.0
Ningbo	772.2	1386.9	79.6	10921	26754	145	4933	11286	128.8
Hefei	1075	1818	69.1	6389	17643	176.1	3655	5608	53.4
Fuzhou	1115.8	1583.3	41.9	7944	20463	157.6	6737	9553	41.8
Xiamen	662.2	1495	125.8	10497	26367	151.2	8032	13423	67.1
Nanchang	1339.4	1707.1	27.5	5734	16293	184.1	2804	5323	89.8
Jinan	3172	3494.4	10.2	8471	22696	167.9	4020	6664	65.8
Qingdao	1835.6	2770.9	51.0	8016	22441	179.9	3306	7166	116.8
Wuhan	4411.4	5630.6	27.6	6761	18647	175.8	4044	6676	65.1
Changsha	1434.8	1993.7	39.0	7530	20016	165.8	3386	5481	61.9
Guangzhou	5361.3	6713.2	25.2	13967	27053	93.7	8058	10926	35.6
Shenzhen	1001.5	2793.7	179.0	20909	28676	37.1	11367	21037	85.1
Chengdu	2276.8	4516.1	98.4	7649	18800	145.8	3972	6361	60.1
Xian	2525.1	3563.9	41.1	6364	20409	220.7	3616	5830	61.2

Source: Statistical Yearbook series of each city (2000-2012), China Population & Employment Statistics Yearbook series (2008-2012), China City Statistical Yearbook series (2001-2007) and China Statistical Yearbook 2012.

Notes: (1) Urban population is measured by the number of residents with an urban household registration.

(2) The income level of urban residents is measured by per capita disposable income.

The approaches to allocating the LURs of urban land vary across different types of land uses. When land is used for public administration, public services, transportation and the special purposes mentioned before, the municipal governments (as a representative of the state) will grant LURs to land users for free, and there will be no stipulated time

period for the granted LURs. When land is used for commercial, industrial and residential purposes, land market plays a leading role in allocating the LURs, and land transactions can be conducted between municipal governments and land users or between different land users. The ways in which residential land is transacted and how they have changed over time will be discussed in detail in next section.

4.2 The Establishment of Direct Government Control over Residential Land Supply

In the early and mid-2000s, the development of land reserve system promoted a structural change in residential land market in urban China, and the municipal governments have become the sole supplier of urban residential land since August 2004.

Before the establishment of direct government control over residential land supply, there were two primary ways for the developers to acquire the LURs of new residential land. First, when urban land parcels were converted from other uses to residential use, the existing land users and the developers could search for each other and negotiate a price for the land. Once they reach an agreement on land price, they would go through the procedure of transferring the LURs at the municipal bureau of land and resources (local land administration authorities). Although this type of land transactions had to get the approval from local land administration authorities and the transaction proceeds would be shared by the existing land users and the local governments, the transactions were essentially initiated by the existing land users and the developers (Peng & Thibodeau 2012; Xie, Parsa & Redding 2002). This type of land transactions frequently occurred when state-owned enterprises or government institutions relocated from central cities to suburbs and transferred their LURs to the developers. As suggested by Peng and Thibodeau (2012), this type of land transactions formed a search-based competitive market for residential land. Secondly, when a parcel of agricultural land was converted to urban residential use, the municipal governments (as a representative of the central government) would conduct land expropriation at first, and then conveyed the LURs of new residential land to the developers. The developers would pay a lump-sum up-front land premium for using the land for 70 years. There are generally four ways for the municipal governments to conduct land transactions with developers, i.e. tender, auction, listing and negotiation. Tender, auction and listing all refer to a process in which the municipal governments make a public announcement to invite individuals or institutions to bid for the LURs of a given land parcel, and when the three approaches are employed, the LURs will be granted to the bidders who offer the highest price. By contrast, when negotiation is employed, there is no competitive bidding and the land premium will be determined by the bargaining between the municipal governments and the land users.

The land reserve system refers to a system under which the municipal governments acquire the LURs of land parcels, conduct preliminary land development (including removing buildings and ancillary structures, site clearance, levelling land, providing water, electricity, road, telecommunications and gas, and dividing the large land tracts into small plots suitable for the conveyance of LURs) and land reserve, and then convey the LURs to land users according to land use planning and urban planning. In practice, the municipal land reserve centre of a city, which is an affiliated agency of the municipal bureau of land and resource, is the major operating entity within the system. Under the land reserve system, there are generally three ways for the municipal governments to acquire the LURs of land parcels. First, as mentioned before, the municipal governments can expropriate collectively-owned rural land and covert it to state-owned urban land. Secondly, when a parcel of urban land is converted from other uses to commercial or residential uses, the municipal government can purchase the LURs from the existing land users, conduct preliminary land development, and then convey the LURs to the new land users. The estimated price of the land parcel based on its current use is usually used as the purchase price that the municipal government pays2. Thirdly, the municipal governments can retrieve the LURs of urban land without payment in the following cases: when the land is unused; when the land lease contracts expire and the existing land user don't apply to extend the contract (or the applications are not approved); when roads, railways, airports and mining sites are approved to be scrapped.

The first land reserve system was set up in Shanghai in 1996. After that, Hangzhou established its land reserve system in 1997, which was viewed as having contributed significantly to an increase in government's control over land market (Qian 2008). In 2001, the central government issued Notice on Strengthening Management of Stated-owned land asset, which encouraged the municipal governments nationwide to establish their own land reserve systems based on Hangzhou's experience. The land reserve system was initiated by the local governments and supported by the central government based on the following considerations. First, it enables the government to exert more strict control over urban land development. Although the transactions between the existing urban land users and the developers (and the related land use conversion) had to get the approval from local land administration authorities according to the relevant laws and regulations, many transactions were actually completed without reporting to the government during the late 1990s and early 2000s. From the perspective of the government, this led to the chaos of land development. Under the land reserve system, the municipal government can impose more stringent control over land development and make sure that the land is developed in a way that is consistent with land use planning. Secondly, land reserve system has been used to prevent the loss of state-owned land asset. Because of the existence of corruption, when the stated-owned

enterprises transferred the LURs to the developers, a large proportion of the transaction proceeds could be put in the pockets of managers of state-owned enterprises, which could lead to the loss of stated-owned land asset. In order to prevent the loss of state-owned land asset, the government intended to reduce the number of transactions between existing urban land users and the developers and acquire more direct control over land supply. Apparently, the development of land reserve system would assist the government in realising its goals. Thirdly, the operation of land reserve system plays an important role in increasing local government revenue. The tax reform in 1993 led to a reallocation of tax revenue between the central government and the local governments. While the tax revenue share for the local governments was decreased significantly, the fiscal pressure on the local governments to provide public service and infrastructure was not lessened at the same time. Under this situation, the local governments have become increasingly relied on the conveyance of LURs to acquire fiscal revenue. Under the land reserve system, the municipal governments can expropriate rural land or purchase the LURs of urban land at a fairly low cost, and then convey the LURs to new land users at a much higher price, and a large proportion of the profit from land sales can be retained by the local governments. Lastly, land reserve system can promote the increase in land use efficiency by bringing idle land into use.

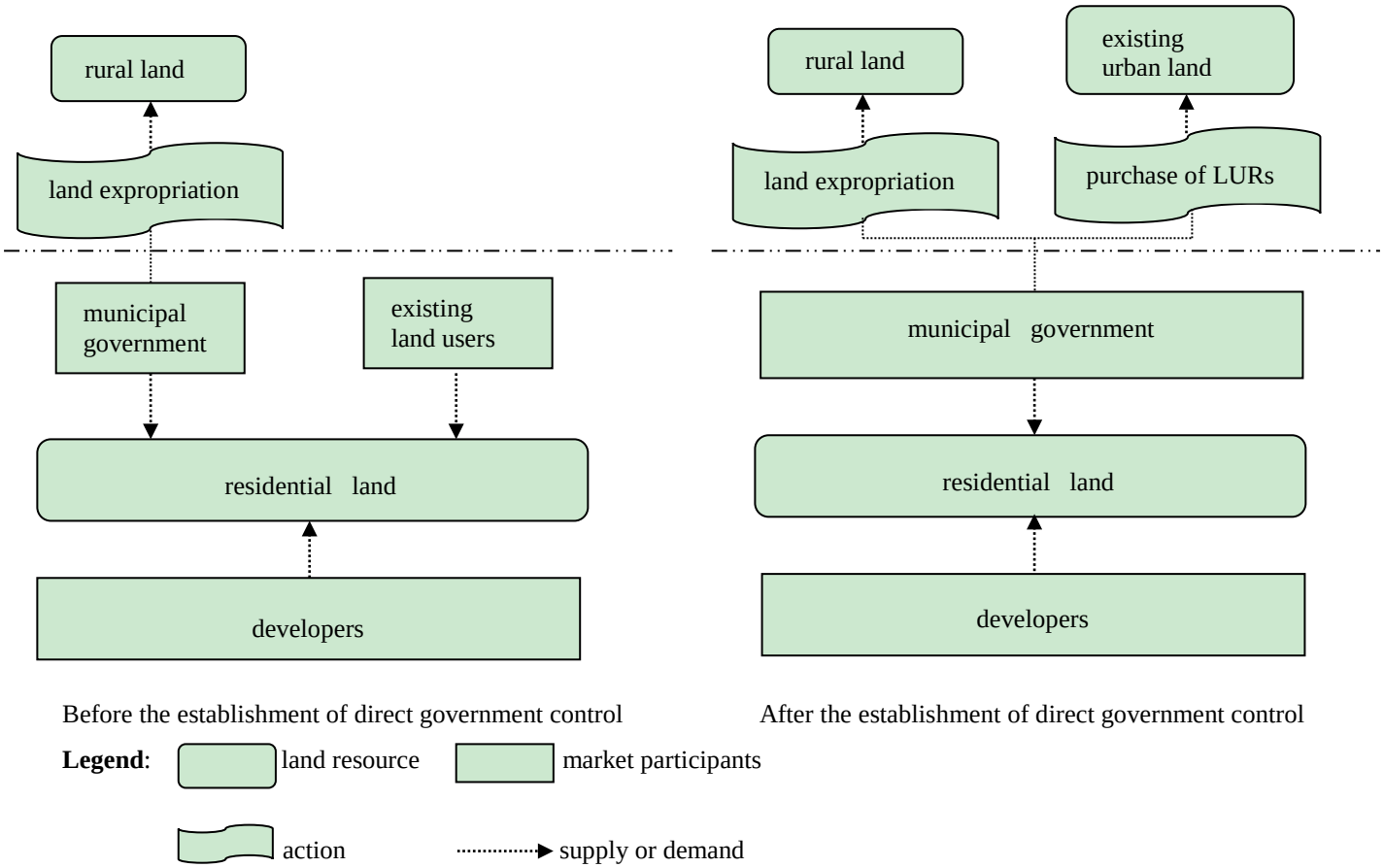

Fig.1 Change in the structure in residential land market in Urban China

It is clear that, under the land reserve system, there was a change in the way in which the residential land was supplied to the developers. When the urban land parcels were converted from other uses to residential use, the municipal governments could purchase the LURs from the existing land users and conduct preliminary land development at first, and then convey the LURs to the developers. However, as suggested by many scholars, the transactions between the existing urban land users and the developers were still a major transaction type in residential land market until August 2004, and the municipal governments didn't have complete control over residential land supply until then. In March 2004, the Ministry of Land and Resources (China's central land administration authority) issued Decree No. 71, which stipulated that all the land used for urban commercial or residential purposes has to be supplied by the municipal governments through tender, auction or listing from August 31th, 2004 onwards. According to the policy, when urban land parcels are converted from other uses to residential use, the existing land users are not allowed to conduct direct transactions with the developers, and the LURs has to be purchased by the municipal governments at first, and then conveyed to the developers. Thus the municipal governments have acquired complete control over residential land

supply since August 2004. Fig.1 shows the structure of residential land market before and after the establishment of direct government control over residential land supply.

4.3 Change in residential land supply before and after the establishment of direct government control over residential land supply

In this subsection, we investigate the change in residential land supply before and after the establishment of direct government control over residential land supply in the 18 major Chinese cities. As shown in Fig.2, for the 18 cities as a whole, annual residential land supply (the site area of the land converted from other uses to residential use and purchased by the developers within a year) increased noticeably from 6182 hectares in 2000 to 12608 hectares in 2002, and stayed relatively high at around 12000 hectares between 2003 and 2004.Iit declined dramatically immediately after the establishment of direct government control over residential land supply (from 11782 hectares in 2004 to 8588 hectares in 2005) and fluctuated around a relatively low level afterwards. The average annual land supply before the structural change in residential land market (10060 hectares) is considerably higher than that after the change (6736 hectares). Fig 3. shows the change in average annual land supply before and after the structural change in residential land market in each city. After the establishment of direct government control over residential land supply, average annual land supply experienced a decrease in 16 cities (Beijing, Shanghai, Nanjing, Hangzhou, Ningbo, Fuzhou, Nanchang, Jinan, Wuhan, Guangzhou, Shenzhen, Chengdu Xian, Hefei, Qingdao and Tianjin), and experienced an increase in only 2 cities (Xiamen and Changsha). It is also worth mentioning that average annual residential land supply decreased by more than 30 per cent in 10 cities (Beijing, Shanghai, Wuhan, Guangzhou, Hangzhou, Fuzhou, Nanjing, Ningbo and Shenzhen). Although many factors (such as increasing scarcity of developable land in central cities and more stringent control over rural-urban land conversion) may have contributed to the decline in residential land supply, these factors alone cannot explain the dramatic decrease in land supply immediately after the establishment of direct government control over residential land supply and the distinctly different patterns of land supply before and after the structural change in residential land market. Thus it is reasonable to argue that the establishment of direct government control over residential land supply played an important role in the decline in land supply.

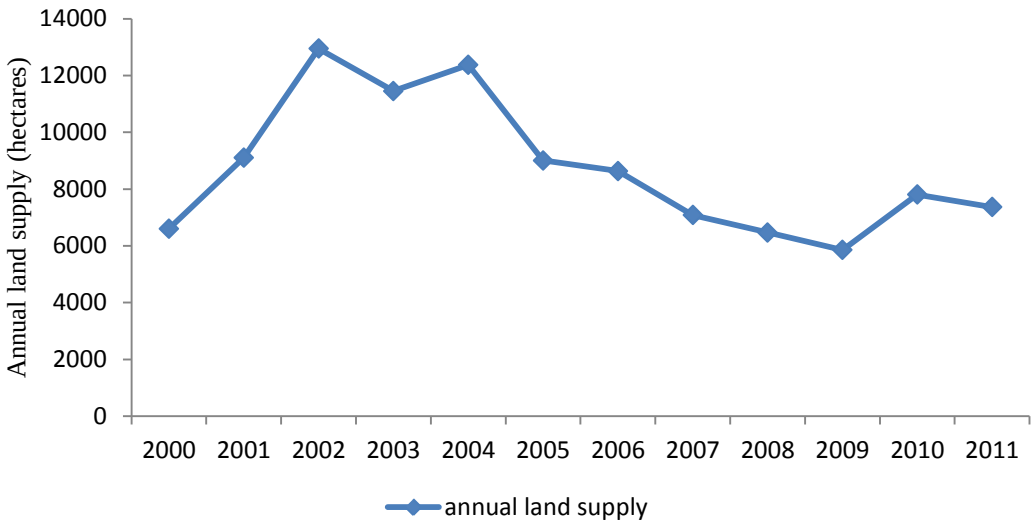

Fig. 2 The course of annual land supply for 18 major Chinese cities for the period 2000-2011

Source: China Statistical Yearbook (2000-2012)

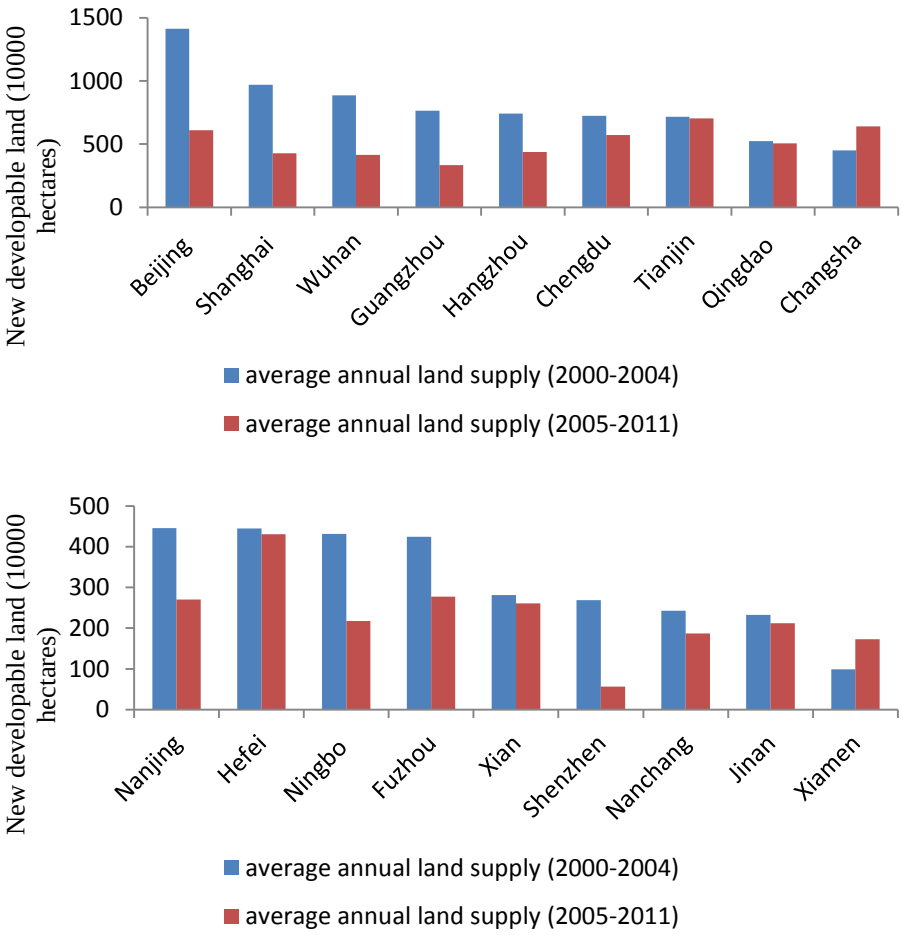

Fig. 3 Change in the average annual land supply before and after 2004 in 18 major Chinese cities

Source: China Statistical Yearbook (2000-2012)

There are mainly two explanations for why direct government control can result in a decrease in residential land supply. First, direct government control can reduce the flexibility of land supply system and make residential land supply less elastic. Before the structural change in residential land market, developers were free to search for developable land and initiate the transactions with existing urban land users, and thus land supply was relatively elastic and can respond relatively adequately to changing market conditions. After the structural change, developers are denied the right to transact with existing urban land users, and they can only wait for the government to put land on the market. Since the amount of the land put on the market within a year is generally determined by the municipal governments at the beginning of each year, land supply is relatively inelastic in the short term. In addition, because preliminary land development has to be completed before new residential land is put on the market and all residential land transactions have to be incorporated into the tender-auction-listing system, the procedures for supplying residential land become relatively complicated after the establishment of direct government control over residential land supply, which also reduces the responsiveness of land supply.

Secondly, the pace of the conversion from industrial/warehousing land to residential use has slowed down since the establishment of direct government control over residential land supply. In the era of planned economy (1949-1978), industrialization was among the top priority of Chinese government. Financial and human capital was disproportionately channelled into industrial sectors, and a large proportion of land was allocated for industrial use (Ding 2003; Feng & Liu 2007; Lu et al. 2010). The economic reform initiated in 1978 led to a rapid industrial growth and a further increase in industrial land use (Feng & Zhou 2005). It is noteworthy that many factories were located in central cities or inner suburbs during that period. In the 1990s, as a result of the development of urban land market, many enterprises began to transfer their LURs to the developers for commercial or residential use and relocated from central cities to the suburbs. The enterprises were highly motivated to do so since they could get considerable transaction proceeds, and the former industrial/warehousing land had become a major source of residential land supply in the late 1990s and early 2000s. However, after the establishment of direct government control over residential land supply, the driving forces behind this type of land conversion has shifted from the existing land users and the

developers to the government, which can significantly slow down the pace of the land conversion. The conversion from industrial/warehousing land to residential use often entails time-consuming and enormously costly process of demolition and land redevelopment. Before the structural change in residential land market, numerous developers were actively involved in the process. After the structural change, the municipal governments usually have to conduct demolition and preliminary land development before putting land on the market, and they may have a limited capacity to complete the task. In addition, the existing land users may feel reluctant to promote the industrial-residential land conversion after the structural change in residential land market. Since the municipal governments usually provide the existing land users with a purchase price which is based on the current use of the land parcels, the transaction proceeds which the existing land users can get in the transactions with the municipal governments is much lower than that they can get in the transactions with the developers. Thus after the establishment of direct government control over residential land supply, some existing land users would rather keep the LURs than sell it to the municipal governments.

5. THE IMPACTS THAT DECREASE IN LAND SUPPLY HAS ON NEW HOUSING SUPPLY AND HOUSING SUPPLY ELASTICITY

In this section, the impact that the decline in land supply after the establishment of direct government control over residential land supply has on new housing supply and housing supply elasticity is examined. Two research hypotheses are proposed. The first hypothesis is that land supply has a positive impact on new housing supply, thus the decline in land supply after the structural change in residential land market has put downward pressure on new housing supply. The second hypothesis is that there is a decrease in the price elasticity of new housing supply after the establishment of direct government control over residential land supply. These two hypotheses are tested by estimating the econometric models of new housing supply, using data for the 18 Chinese cities for the period 2000-2011.

4.3 Development of models of new housing supply

As mentioned in the section of literature review, the factors affecting new housing supply mainly include housing prices, construction cost, financing cost, land supply, planning controls and climate conditions. The independent variables in the model are chosen to capture the effects of those factors on new residential construction. Also, as mentioned earlier, an important issue in modelling new housing supply involves whether it should be specified as a function of the levels of housing price and cost variables or as a function of the changes in price and cost. Following Mayer and Somerville (2000b) and many other scholars (Ball, Meen & Nygaard 2010; Hwang & Quigley 2006; McLaughlin 2012; Meen & Nygaard 2011; Zabel & Paterson 2006), new housing supply is specified as a function of the changes in housing price and cost variables in this study based on the following considerations. First, housing starts occurs in response to changing market conditions (such as the increase in the demand for housing) that require a growth in the housing stock relative to last period. While the equilibrium level of housing price matches housing stock with the demand for housing, it is the changes in housing price and construction cost that will influence the change in housing stock or new housing supply. Secondly, modelling new housing supply as a function of the changes in housing price and cost variables is more consistent with the temporary response of new residential construction to housing price growth. As mentioned previously, following a favourable demand shock, an increase in housing price will lead to a temporary rather than a permanent increase in building activities. As increased land price moves the cost of housing production towards housing price, existing housing stock will gradually adjust to the equilibrium level and building activities will eventually return to its normal level. Thirdly, since new housing supply is a flow variable, it should be specified as a function of other flow variables and the changes in the stock variables. The model of new housing supply takes the following form:

$$InHS_{it} = \beta_0 + \beta_1 \Delta InHP_{it} + \beta_2 \Delta InCCOST_{it} + \beta_3 \Delta InRINT_{it} + \beta_4 InLS_{it} + \beta_5 InLS_{it-1} + \cdots + \beta_{k+4} InLS_{it-k} + \alpha_i + \lambda_t + \varepsilon_{it} \quad (1)$$

Where $InHS_{it}$ represents the log of new housing supply in city i during year t, $\Delta InHP_{it}$ is the change in the log of housing price in city i during year t, $\Delta InCCOST_{it}$ is the change in the log of construction cost in city i during year t, $\Delta InRINT_{it}$ is the change in the log of financial cost in city i during year t, $InLS_{it}$ is the log of land supply in city i during year t, $InLS_{it-k}$ is the lag of (log) land supply, α_i is a city-specific effect, λ_t is a vector of year-specific dummy variables, and ε_{it} is the idiosyncratic error. The coefficient on $\Delta InHP_{it}$ is the estimate of the price elasticity of new housing supply for the full sample period (2000-2011).

The city-specific effects allow for time-invariant and cross-section specific effects that affect building activities. Since geographical features, climate conditions and regulatory stringency vary substantially across cities but are relatively invariant over time, the impacts of those factors on housing starts can be captured by the city-specific effects.

Since developers have to go through various administrative formalities before starting construction, there is generally a time interval between acquiring new residential land and starting construction, and land supply tends to affect housing starts with a lag. As suggested by Zhong, Zhu and Li (2006), the pre-development process can be divided into three stages in urban China. The first stage involves obtaining land use permits from urban planning authorities, and the second stage results in completing project designs and obtaining planning permits. The developers would choose building contractors through a bidding process and obtain building permits at the final stage. Zheng (2008) and Ye (2009) argue that, it generally takes one to two years for the developers to complete the pre-development process and in some cases the process can last even longer because the planning parameters are subject to unexpected adjustment by the urban planning authorities. In this study, up to 5-year lag of land supply are included as independent variables in the model to test the lagged effects of land supply on new housing supply. Since land supply is a flow variable as new housing supply, it appears in the housing supply equation in the level form.

Since the profit of new residential construction increase with housing price and decrease with the cost of housing production, it is expected that the change in housing price ($\Delta InHP_{it}$) should have positive coefficient and the changes in construction cost and financial cost ($\Delta InCCOST_{it}$ and $\Delta InRINT_{it}$) should have negative coefficients. As land supply is expected to have a positive impact on new housing supply, the land supply variables ($InLS_{it}$, $InLS_{it-1}$, …, $InLS_{it-k}$) should bear a positive sign.

To undertake a formal test of the hypothesis that there is a statistically significant decrease in the elasticity of new housing supply after the establishment of government monopoly on residential land supply, an interaction term $\mathrm{D}_{0611} \times \Delta\mathrm{InHP}_{\mathrm{it}}$ is added to model (1) to allow the housing supply elasticity to vary over time:

$$lnHS_{it} = \beta_0 + \beta_1 \Delta lnHP_{it} + \beta_2 D_{0611} \times \Delta lnHP_{it} + \beta_3 \Delta lnCCOST_{it} + \beta_4 \Delta RINT_{it} + \beta_5 \mathrm{lnLS}_{\mathrm{it\text{-}1}} + \beta_6 \mathrm{lnLS}_{\mathrm{it\text{-}2}} + \alpha_{\mathrm{i}} + \lambda_{\mathrm{t}} + \varepsilon_{\mathrm{it}} \quad (2)$$

where D_{0611} is a dummy variable that is zero for the period 2000-2005 and one for the period 2006-2011. In model (2), β_1 represents the estimate of housing supply elasticity for the period 2000-2005, the sum of β_1 and β_2 represents the estimate of housing supply elasticity for the period 2006-2011. A negative and significant coefficient β_2 would indicate that there is a decline in housing supply elasticity after the structural change of residential land market.

4.3.1 Variables definitions and data source

New housing supply (HS) is measured by the floor area of housing starts. As mentioned before, apartment units constitute the vast majority of housing units in urban China. In 2011, new residential construction in urban China was composed of 141510.10 hectares of apartment units (96.2%) and 5653.01 hectares of villas and luxury homes (3.8%). Data on the floor area of housing starts at the city and year level are sourced from China Real Estate Statistics Yearbook series (2001-2012), which are compiled by China's National Bureau of Statistics and China Index Academy.

Housing price is the average price of commodity housing. The average price of commodity housing at the city and year level is calculated by converting the Housing Price Index for large and medium-sized cities compiled by China's National Bureau of Statistics to housing price levels[2]. China's National Bureau of Statistics established the Housing Price Index for 35 large and medium-sized cities in 1997, and all the sample cities in this research are included in the 35 cities[3]. This index is the best available housing price index in China and has been widely used by studies published in SSCI-listed journals (see, e.g.)

Construction cost ($CCOST$) is measured by the cost to build the physical structure of the housing units (excluding the cost of land). Data on the cost to build the physical structure of the housing units is sourced from China Real Estate Statistics Yearbook series (2001-2012).

Financial cost ($RINT$) is measured by the 1-3 year term benchmark bank loan rate (in real term). Banks are not free to set interest rates in China, and the People's Bank of China (China's central bank) guides the interest rates offered by banks through setting the benchmark interest rates and the floating range. The interest rates on real estate development loans can only fluctuate within a stipulated floating range around the 1-3 year term benchmark bank loan rate. Thus there is little variation in the interest rates on construction loans across regions. Data on the 1-3 year term benchmark bank loan rate is collected from the report of the People's Bank of China.

Residential land supply (LS) is the land converted from other uses to residential use and purchased by the developers within a certain time period. Ideally, the plot ratio of the land parcels should be controlled. However, Since there is no data on plot ratio, this issue is not considered. In addition, the proportion of large or small developers in the property development market should be considered since developers' heterogeneity can influence land supply through land price

(Dong & Sing 2013). However, this issue is not considered due to data availability. Data on the amount of land supply at the city and year level are sourced from China Statistical Yearbook series (2001-2012), which are compiled by China's National Bureau of Statistics.

4.4 Empirical results

Table 2 shows the estimates of model (1) and model (2). Column (i) in table 1 reports the estimates of model (1) when up to 5-year lag of land supply is included as independent variables. The change in housing price has a positive and statistically significant impact on new housing supply. The estimate of the housing supply elasticity is 1.532 for the full sample period (2000-2011). As documented in many previous studies (Blackley 1999; Dipasquale & Wheaton 1994; Mayer & Somerville 2000b; Poterba 1984; Pryce 1999; Topel & Rosen 1988), the coefficient on the change in construction cost is not statistically different form zero and has an unexpected positive value. One explanation for the poor performance of the construction cost variable is that, since new housing supply and construction cost tend to be simultaneously determined, treating construction cost as an exogenous variable in the housing supply model can cause simultaneity bias. A primary approach to dealing with the simultaneity bias is to use the instrumental variable approach. However, as in most of the previous studies, we are unable to find appropriate instruments for the construction cost variable due to data availability. The change in financing cost has a negative and statistically significant effect on new housing supply, and the effect is sizable in magnitude. A one-percent-point rise in real interest rate can reduce new residential construction by 5.8%. The coefficients on the land supply variables are all positive as expected, but only the coefficients on the 1-year and 2-year lag of land supply are statistically significant. This finding is consistent with the fact that there is generally a time interval of one or two years between acquiring new residential land and starting construction. It is also interesting to find that, among all the land supply variables, 1-year and 2-year lag of land supply have the largest effect on new housing supply, with a 1% rise in 1-year and 2-year lag of land supply increasing new housing supply by 0.121% and 0.125%, respectively. Column (ii) reports the estimates of model (1) when the insignificant land supply variables are excluded. The exclusion of the insignificant land supply variables slightly increases the size of the coefficient on the change in housing price (from 1.532 to 1.582), slightly reduces the size of the coefficient on the change in financing cost (from -0.058 to -0.055), and substantially increases the size of the coefficients on the 1-year and 2-year lag of land supply (from 0.121 to 0.199, and from 0.125 to 0.214, respectively). It is also noteworthy that, once the insignificant land supply variables are excluded, there is an increase in the explanatory power of model (1) (with adjusted R^2 increasing from 0.554 to 0.617). Since all the independent variables are statistically significant in column (ii) and the explanatory power is also relatively higher than that in column (i), the estimates in column (ii) is the preferred estimates of model (1).

Column (iii) reports the estimates of model (2). It is worth noting that, in model (2), the coefficient on the change in housing price represents the estimate of the housing supply elasticity for the period 2000-2005, and the sum of the coefficient on the change in housing price and the coefficient on the interaction term represents the estimate of the housing supply elasticity for the period 2006-2011. The coefficient on the interaction term is -1.818 and statistically significant. This implies that, after the establishment of government monopoly on residential land supply, there is a remarkable decrease in the price elasticity of new housing supply from 2.429 for the period 2000-2005 to 0.611 for the period 2006-2011. The coefficients on the change in financing cost and the coefficients on the 1-year and 2-year lag of land supply are almost identical to those in column (ii), and again, they are all statistically significant.

All in all, the empirical results support the hypothesis that land supply has a positive impact on new housing supply, thus the decline in land supply after the establishment of government monopoly on residential land supply has put a downward pressure on new housing supply. The empirical results also support the hypothesis that there is a decrease in housing price elasticity after the establishment of government monopoly on residential land supply.

Table 2 Estimates of the models of new housing supply

Dependent variable: $InHS_{it}$			
Independent variables	(i)	(ii)	(iii)
$\Delta InHP_{it}$	1.532* (0.816)	1.582* (0.875)	2.429** (1.062)
$\Delta InCCOST_{it}$	0.105 (0.123)	0.020 (0.094)	-0.020 (0.091)
$\Delta InRINT_{it}$	-0.058*** (0.007)	-0.055*** (0.007)	-0.052*** (0.007)
$InLS_{it}$	0.012 (0.086)		
$InLS_{it-1}$	0.121** (0.056)	0.199*** (0.063)	0.198*** (0.065)
$InLS_{it-2}$	0.125* (0.061)	0.214*** (0.053)	0.215*** (0.052)
$InLS_{it-3}$	0.069 (0.068)		
$InLS_{it-4}$	0.057 (0.038)		
$InLS_{it-5}$	0.057 (0.044)		
$\Delta InHP_{it} \times D_{0511}$			-1.818* (1.012)
Adjusted R^2	0.554	0.617	0.621
F statistic	53.07***	161.8***	95.42***

Notes: (1) Robust standard errors are reported in parentheses below parameter estimates, and robust *t* statistics are reported in square brackets.

(2) * denotes significance at the 10% level, ** at the 5% level and *** at the 1% level.

5. CONCLUSION

This paper examines the impact that direct government control over residential land supply has on real estate markets in major Chinese cities. It is found that there is a significant decline in land supply in most of the cities after the establishment of direct government control over residential land supply, and the decline in land supply has put downward pressure on new housing supply. It is also found that there is a noticeable decline in housing supply elasticity after the structural change in land market.

Peng and Wheaton (1994) examine the impact of land supply on new housing supply in Hong Kong which also has a leasehold land tenure system as mainland China. They found that land supply has no significant impact on new housing supply. They argue that, this is due to the fact that there isn't very stringent restriction on density and floor area ratio in Hong Kong so that the developers can substitute the structural capital for land relatively freely. The widespread practice of land hoarding by property developers also prevents the conversion of land supply into new housing supply. By

comparison, the restriction on density and floor area ratio is relatively strict in mainland China, and land hording is not as serious as in Hong Kong. Thus it is not surprised that a significant positive relationship between land supply and new housing supply can be found in this study.

If there is not a change in the residential land supply system, given that the efficiency of land conversion from other urban uses to residential use is relatively low, land supply might continue to be relatively restricted in the future. Breaking the government's monopoly on land supply and letting existing land users and developers play a more active role in land supply might be a plausible way to increase the residential land supply.

Notes

1. In China's system of political geography, provincial level division is the highest-level administrative division. There are 34 such divisions, classified as 23 provinces, 4 province-level municipalities, 5 autonomous regions and 2 Special Administrative Regions. Province-level municipality is the highest level classification for cities in China. Provincial-level municipalities are not part of provinces, but independent entities whose leaders report directly to the central government. A provincial capital is generally the administrative, economic and transportation hub of a province. A sub-provincial city is governed by a province, but is administratively independent in regard to economy and law. The status of sub-provincial cities is above the status of regular prefecture-level divisions which are completely ruled by their provinces.

2. The data on the average price of commodity housing for each city in 2011, which enables the conversion of housing price index to housing price levels, is available from China Statistical Yearbook 2012.

3. There is an individual housing price index for each of the 35 cities. The coverage of the Housing Price Index expanded to 70 cities in 2005, and all the sample cities in this research are still included in the 70 cities.

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