Government Policy and Land Price Dynamics: A Quantitative Assessment of China's Factor Market Reforms*

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Abstract

This paper examines the role played by government policy regarding factors of production in shaping the dynamics of a growing economy. Using land as an example of an important productive factor, we develop a quantitative model with endogenous land price policy regimes to rationalize the following three economic reforms in China: introduction of non-SOEs (state-owned enterprises); reform of SOEs characterized by their retreat from the competitive manufacturing sector and the establishment of state monopolies in factor markets around 2000; and a regime switch from dual-track land pricing to land price discrimination by use. We calibrate our model to key economic indicators for China and quantify the effects of these reforms. Our calibrated model can match several stylized facts for China after 2000 such as widening disparity in land prices by use, rapid growth in housing price, land revenue, and government expenditures on public goods, and the steep decline in labor share for income.

Keywords: Dual-track Pricing, Land Price Discrimination, State Monopoly, Land Market Reforms.
JEL Classification Numbers: Q15, R38, H71, E25, O18.

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1 Introduction

Since 1978, China introduced a series of economic reforms that have played an important role in shaping China's economic growth experience in recent decades (Zhu, 2012). Two important kinds of reforms were the reforms of the state owned enterprises (SOEs) and the reforms in the factor markets in China.[1] Throughout the reform period the Chinese economy experienced wide-ranging changes.[2] First, between 1980 and early 1990s there was a rise of non-SOEs in the competitive manufacturing sector, followed by a large-scale retreat of the SOEs from this sector in the late 1990s (OECD, 2009). Second, the government and the remaining large SOEs established monopolies in key industries such as land, petroleum, coking, nuclear fuel, raw chemical material, transport equipment, mining, and utilities (OECD, 2009). Third, this period was also characterized by the emergence of a land market, and the evolution of the land price policy. Before the large-scale retreat of the SOEs began in late 1990s, the land price policy manifested as a dual-track pricing aimed at protecting inefficient SOEs by setting a relatively higher land price for non-SOEs (Zhang, 1997).[3] By early 2000s the Chinese government introduced reforms aimed at using market-based mechanisms such as auctions and tenders to supply land to developers and private users (Peng and Thibodeau, 2012; Wu et al., 2015; Du et al., 2011).

During this period of reforms the Chinese economy also experienced dramatic changes in land price levels, relative land prices by use, the composition and size of government revenue, provision of public goods and social benefits, and the labor share of income.[4] In

[1] See Li (1997), Groves et al. (1995), Lin et al. (1998), and Lin et al. (1999) for the detail and impact of early stages of SOE reforms.

[2] For example, Young (2003) document the productivity growth in the non-agricultural sector and Lin (1992) studies the agricultural sector's growth.

[3] Lau et al. (2000) define a dual-track system with two tracks, namely, a plan track and a market track. They argue that the objective of such a system was to achieve "reforms without losers" , by continuing the quantity and price restrictions under the plan track. However, after firms meet their obligations, they were allowed to participate in both input and output markets and transacted at market prices.

[4] Zhang et al. (2013) use data from China Statistical Yearbook, 2011, and document a steady rise in the government expenditure on public goods such as transportation, electricity, and postal and telecommuni-

Figure 1 we plot the relative land prices in China by use since 2000.[5] It can be observed that since 2000 land prices have increased rapidly, residential land prices are substantially higher than industrial land prices, and there is an increasing disparity between these two prices. This pattern remains unchanged even after controlling for quality differences, e.g., distance to central business districts.[6] The rising land prices for the residential land use are accompanied with the rising share of land grant premiums in local fiscal revenues (see Figure 2).[7] Finally, Figure 3 plots the labor share of income in China from 1978 through 2007. Bai and Qian (2010) noted that there were substantial changes in the methods of estimating labor compensations used by the National Bureau of Statistics of China since 2004. The labor share data from Figure 3 had been adjusted for those changes. We find an inverted U-shaped pattern, with a rising trend till 1998, and thereafter a rapid decline till the end of the sample period.[8]

In this paper, we propose a theoretical framework that captures the aforementioned features of the reforms of SOEs and land market in China and matches the stylized facts underscored in Figures 1-3. Our model endogenously determines three regimes that capture the evolution of the land price policy in China: 1978-1988 (need-based land allocation), 1989-1998 (dual-track system or price discrimination according to the ownership types of firms), and after 1998 (price discrimination based on land uses).[9] In addition to the land price

cation services. They report that public expenditure on infrastructure projects increased from 0.9% of the GDP in 1997 to 3.7% in 2010.

[5]The land transaction data before 2000 is scarce and hence in this graph we are only plotting publicly available data on such transactions from 2000.

[6]The quality-adjusted relative land prices are computed using the Hedonic price method (see Appendix B).

[7]A similar trend is documented in Fang et al. (2016). Note that in China local governments typically use these revenues to expand the provision of public goods and social benefits (Wu et al., 2015).

[8]China has witnessed one of the steepest declines in labor share since 1990s among the top eight economies ranked by gross domestic product (Karabarbounis and Neiman, 2014).

[9]In this paper, we use land as an example of key productive resources and highlight the dual-track nature of pricing of this factor in China during the early phase of economic reforms (before 1998). However, the pricing of several other key factors of production (e.g., capital, coal, labor, and steel) also followed this dual track system (Qian, 2003; Liew, 1993).

policy, our model also captures an important reform of SOEs known as *zhuada fangxiao* i.e. "attaining the larger, releasing the smaller" which began around 1997 (Ho and Young, 2013; Zheng and Chen, 2009). In our theoretical framework, we interpret this reform as the large-scale retreat of the SOEs from the competitive manufacturing sector and the establishment of market power in the profitable land (factor) market. After the large-scale retreat of the SOEs, the land market witnessed a switch to a regime of price discrimination aimed at encouraging economic growth and raising land revenues from households by imposing a higher land price on households when compared to industrial users (Wu et al., 2014; Du et al., 2011). We use the monopoly power of the government in the land market to represent the market power of large SOEs observed in China since 2000 (OECD, 2009; Zheng and Chen, 2009).

Our paper complements the existing literature that associates the gradual nature of economic reforms in China with the dualism in factor markets to protect SOEs against the competition of non-SOEs.[10] This literature emphasizes various capital and labor market distortions in China. For example, Gordon and Li (2003) highlighted the interest rate control, price discrimination, and other restrictions in China's financial market; Song et al. (2011) study the dual-track system in the capital market. Guariglia et al. (2011) document that SOEs are not affected by the financing constraints faced by non-SOEs in China. Lau et al. (2000) consider the dual track approach to transition in consumption good markets and labor market. Au and Henderson (2006) study the effect of rural-urban migration restrictions, or hukou system.[11] In contrast to this literature's focus on labor and capital markets, our paper highlights the importance of land price distortions in the growth dynamics of China.

We calibrate our model to match key data moments for the Chinese economy between

[10]This provides an alternative to the the optimal speed of transition studied in Castanheira and Roland (2000).

[11]See Meng (2012) for more information on rural-urban migration restrictions and other aspects of China's labor market.

1978-2010 and interpret the land price dynamics in China. There are several findings of interest. First, our model explains more than half of the rising land price disparity between industrial and residential users during 2000-2010. Second, we can explain more than two-third of the increase in real government expenditure on public goods and social benefits observed in China during 1989-2010.[12] The land price policy channel emphasized in our model is quantitatively important. For instance, it captures the nature of public finance in China since 2000, which increasingly relies on taxes effectively collected in the form of land sales revenues with the local governments acting as a monopoly in the land market.[13] Furthermore, this channel is also important for the dynamics housing expenditures which accounts for a large share of household annual income.[14] Finally, the policy induced land price dynamics in our model can also explain the observed pattern of labor share in China, with a steep decline in this share since 2000.

The remainder of the paper is organized as follows. Section 2 provides a brief review of the related literature. Section 3 presents our model and the results of the calibration exercise. Section 4 presents the main quantitative implications of our model and Section 5 concludes.

2 Related Literature

In this section we provide a brief review of the literature that supports the key assumptions of our theoretical framework and the nature of SOEs and land market reforms in China.

An important assumption of our model is that the government has an incentive to maintain the size of the SOEs in the economy. This assumption is grounded in the role played

[12] In our model the rising incomes and higher land prices for housing provide a steady stream of land revenues for the government to expand provision of public goods and social benefits.

[13] Fang et al. (2016) document that land revenues account for more than 60 percent of local fiscal budget since 2003.

[14] Fang et al. (2016) estimate that about 46.7 percent of a household's annual income is accounted for by mortgage payments.

by the SOEs in China. In urban areas they were largely responsible for ensuring social stability and assumed an important position in the social welfare system by providing various public services, housing and other important benefits to their employees (Brandt and Zhu, 2010; Zhu, 2012; Wen, 2004). Further, Shleifer and Vishny (1994) argues that, SOEs were a source of political benefits for the government and through provision of above market-wage employment the government accumulated political capital in SOEs, making the government less inclined to shutting down SOEs.[15]

In our model the productivity of the non-SOEs relative to the SOEs plays an important role in determining different regimes in the land price policy. We assume a faster rate of productivity growth for non-SOEs when compared to SOEs. This assumption has a strong support in the literature. For example, Zhu (2012) documents that between 1978-2007 the total factor productivity (TFP) in the non-agricultural sector grew at an annual average growth rate of 3.91% whereas the comparable growth for the state sector was 1.68%. Similarly, Song et al. (2011) find that labor productivity grew faster in areas with a larger share of non-SOEs.[16]

For simplicity, we assume that the only way for the government to protect inefficient SOEs from rising private sector competition is through the distortive factor pricing.[17] The literature has studied different kinds of protection. For example, Brandt and Zhu (2000) and Zhu (2012) study the government subsidies and access to credit to the SOEs. Brandt

[15]Because of their important role in urban areas, SOEs were not allowed to adjust their workforce to changing market conditions due to the entry of more efficient non-SOEs who did not face similar constraints (Bai et al., 2001).

[16]Note that the productivity dynamics changed in the recent period. For example, during 1998-2007 the SOEs witnessed a faster growth in TFP when compared to non-SOEs (Brandt et al., 2012; Zhu, 2012). Similarly, Hsieh and Song (2015) document that between 1998 and 2007 the labor productivity gap between SOEs and non-SOEs narrowed significantly, although there remains a significant gap between them in terms of capital productivity. Further, they find that this convergence in relative labor productivity has slowed down in more recent years. Many studies argued that this improved performance was mostly due to the monopoly benefits that SOEs were able to reap in the post-2004 period (Zheng and Chen, 2009).

[17]Without this kind of protection the inefficient SOEs will be driven out of the market in our model. Also, note that during this period, SOEs controlled by different local governments also competed in the market (Li, 1997).

and Zhu (2000) document that, between 1986 and 1993 the size of the transfer from the government to SOEs showed a secular rising trend and a principle source of such transfers was the financial system. However, the dual-track system that was established in 1985 (Zhu, 2012; Liew, 1995; Li, 1997) was one of the most important ways for the government to protect SOEs. For example, a dual-track system in the capital market ensured that SOEs paid a lower interest rate than non-SOEs (Song et al., 2011). Similarly, the government also used dual-track pricing in the factor markets such as land, raw material to protest SOEs (Lin, 2012; Lin et al., 1995). In our model, we use the dual-track pricing in the land market as an example of the dual-track pricing in the factor market that was established with the objective of protecting SOEs. Specifically, in the land market, Zhang (1997) finds that the SOEs only paid a compensation fee determined by the local government to cover relocation expenses for original occupiers where as commercial land users traded land use rights (LURs) in the market, typically at a higher market price.

An important feature of our model is the role played by the SOEs as the supplier of land in the early policy regimes, and the establishment of the government monopoly in the land market in the latter regime. This feature of our model finds support in the reforms of the land market in China. Prior to 2004, there were two main channels for re-purposing urban land from other uses to residential use in China. First, existing land users, typically SOEs, can transfer land use rights (LURs) to developers (Peng and Thibodeau, 2012). Second, local governments can purchase LURs from existing land users and then transfer them to developers. Hence, local governments and SOEs were the main suppliers of urban residential land prior to 2004 (Yan et al., 2014). Two major reforms in the land market helped establish absolute monopoly of local governments over urban land supply since 2004. First, in 1998 the SOEs were prohibited from providing housing to their workers forcing a large majority of urban households to participate in the private housing market (Yan et al., 2014). Second, from August 2004 onwards, local governments used tender, auction, or listing to supply

urban land to developers and other private users (Peng and Thibodeau, 2012; Wu et al., 2015; Du et al., 2011). Given that local governments already had the authority to convert rural land for urban use, the last reform effectively established absolute monopoly of local governments over urban-use land.[18]

In our theoretical framework, we interpret an important SOEs reform, that can be described as "attaining the larger, releasing the smaller (zhuada fangxiao)", as the large-scale retreat of the SOEs from the competitive manufacturing sector and the establishment of market power in the profitable factor markets.[19] Our model is also able to explain why this phase of SOEs reform and the reform in the factor (ex., land) markets happened at the same time (during 1998-2004), for which a lot of evidence was studied in the literature. First, according to Ho and Young (2013), between 1997 and 2003, the SOEs reforms aimed to privatize unproductive small SOEs, improve efficiency by laying off excess labor, and finally to consolidate market power in important industries through mergers and corporatisation of large SOEs. Second, in 1997 the number of laid-off SOE workers (xiagang) stood at 6.92 million and this number gradually stabilized reaching 1.53 million by 2004 (Brandt and Rawski, 2008). Third, the State-owned Assets Supervision and Administration Commission (SASAC) was established in 2003 to supervise SOEs reforms and restructuring and asset management. After this reform, an important development in the post 2003 period in China was the large scale retreat of SOEs from competitive labor intensive industries and the establishment of state monopolies in key industries (OECD, 2009). For instance, in 2006 the state sector contributed less than 10% of industrial output of labor intensive industries such as textile, leather, food and beverages whereas it continued to be a dominant player in capital intensive industries such as petroleum, coking, transport equipment, utilities, etc. Similarly,

[18] After the reform in 2004, a majority of the land for industrial use continued to be allocated based on negotiations. Because of this another regulation related to industrial land use was enacted in 2007.

[19] The decrease in the size of SOEs coupled with the widespread losses made by SOEs in early 1990s triggered this phase of SOEs reform.

Hsieh and Song (2015) document that the rate of privatization was highest among mid-sized SOEs and lowest among the largest SOEs. In our model, we use the state monopoly in the land market as an example of the state monopolies in the factor markets in China post the reforms of the SOEs.

Our paper is also related to the growing literature on rising land and housing prices in China. In our model, we attribute the rapid rise of land price to the establishment of the government monopoly in the land market which allows reduction in residential land supply and extraction of higher price from households who experience rising incomes due to the expanding non-SOEs. An important development in the Chinese land market was the reduction in residential land supply and the rapid rise in land and housing prices after 2004. For instance, Yan et al. (2014) use data on sixteen cities and find that the annual residential land supply declined by approximately 29% between 2004 and 2005. They also document that the average annual land supply was much lower in the 2005-2011 period when compared with the 2001-2004 period. Many studies have documented the importance of relatively inelastic housing (land) supply in explaining the rise of housing price in China (Chen and Wen, 2017; Garriga et al., 2016; Glaeser et al., 2017; Wang and Zhang, 2014). Moreover, Glaeser et al. (2017) document that Chinese housing stock grew proportionately more in locations that were less productive, which may also be a reason for the rapid rise of housing price in China. Using constant quality housing price index, Wu et al. (2016) document that the housing prices have risen at an average of 10 percent per annum since 2004. They find that between 2001-2012, the supply of housing has not kept pace with the demand with the supply-demand ratio averaging around 90% during this period. There is also a role played by rising demand for housing after privatization of the housing market. After 1998 most urban households were forced to participate in the private housing market as state units stopped providing housing to their employees (Yan et al., 2014). Using panel data from the China Health and Nutrition Survey, Wang (2011) compares the housing consumption for households

living in state employers-provided units with observationally equivalent households residing in private homes. She finds that on average households consumed 15 percent less housing services under the state-controlled regime. As a result, housing market reforms increased the demand for housing from these consumers after privatization and this in turn contributed to the rapid rise in housing prices observed in China before 2004. Another source for rising housing demand is the rising incomes in urban areas. For instance, using data on housing price and mortgage borrowers, Fang et al. (2016) documented that the rapid rising housing price in more major cities in China was accompanied by similarly growth in household income. Garriga et al. (2016) use data in China for the period 1998-2012 and document a faster housing price growth in cities that experienced greater net inflows of rural migrants during this period. They find that rural-urban migration, land supply restrictions, and productivity growth account 80.5 percent of the housing price growth between 1998 -2012 in China. However, because Garriga et al. (2016) assume that land supply is exogenous, they are not able to capture the effect of state monopoly in the land market, a channel we capture in this paper. Furthermore, the framework of Garriga et al. (2016) cannot explain why urbanization and migration resulting from structural transformation did not lead to rapid rise in housing price before 1998. Finally, Chen and Wen (2017) argue that the reason for much faster growth in housing price when compared to average disposable income is due to a housing price bubble in China, with limited supply of financial assets and search for high capital returns rendering housing as an attractive asset for investors.

3 Model

3.1 Economic Environment

Consider an economy populated by L_t number of infinitely lived households (workers) in period t. There are three perishable goods in the economy: a consumption good, housing

services, and social benefits, denoted by c, h, and b, respectively.[20]

3.1.1 Production

The consumption good is produced competitively by SOEs and non-SOEs. SOEs are owned by the government whereas the non-SOEs are owned equally by all households. Let s and p denote SOEs and non-SOEs, respectively. Without loss of generality, we assume that:

$$0 < A_{s,0} = A_{p,0}. \tag{1}$$

Subsequently, we assume that the productivity of the non-SOEs grows at a faster rate when compared to that of the SOEs.[21] The production of the consumption good requires inputs of labor and land. We assume Cobb-Douglas production function forms:

$$Y_{i,t} = A_{i,t} N_{i,t}^{1-\alpha} L_{i,t}^{\alpha}, \tag{2}$$

where $0 < \alpha < 1$, $N_{i,t}$ is land input, $L_{i,t}$ is labor input, and $A_{i,t}$ denotes the productivity for firm $i = s,\ p$. Given land prices ($R_{i,t}$) and wage rates (w_t), each type of firms maximizes profits from production.

Land is used as an only input in the production of housing services and the technology is given by:

[20] We treat social benefits in an abstract way. It may include medical care, pension benefits, education and public goods.

[21] See Zhu (2012) for empirical evidence on this assumption. Further, as discussed in Section 2 of this paper, in recent years the productivity dynamics has changed with the gap between SOEs and Non-SOEs narrowing between 1998 and 2007. However, Hsieh and Song (2015) document that this convergence in relative labor productivity has slowed down in more recent years. Further, this improved performance for SOEs can be attributed in part to the their monopoly power in key factor industries in the post-2004 period (Zheng and Chen, 2009).

$$H_t = N_{h,t}, \tag{3}$$

where $N_{h,t}$ is the amount of land input. We make the simplifying assumption that the labor share in the housing sector is zero.[22]

Social benefit is produced from the consumption good. The production function is given by:

$$B_t = Y_{b,t}. \tag{4}$$

3.1.2 Households

Each household provides one unit of labor in each time period. Households have a discount rate ρ. A representative household's period utility is given by:

$$U(c_t, h_t, b_t) = \phi_2 \left[\phi_1 (c_t)^{\zeta} + (1-\phi_1) h_t^{\zeta}\right]^{\frac{1}{\zeta}} + (1-\phi_2) b_t, \tag{5}$$

where c_t denotes the consumption good, h_t denotes consumption of housing services, and b_t is the consumption of social benefits. We normalize the price of the consumption good to one. $\zeta < 0$ implies housing services and consumption good are gross complements.[23] Finally, we assume that the household's utility from social benefits depends on the average level of social benefits in the economy, i.e., $\frac{B_t}{L_t}$. Hence, the household has no incentive to produce

[22]There are three important input factors of housing production: labor, capital and land. Labor share should be very small relative to land input share in housing production. For simplicity, we abstract from capital in our model and assume that the labor share is zero in housing production. However, for our key mechanism to explain labor share dynamics, it only requires labor share in housing production to be smaller than that in goods production.

[23]The assumption of complementarity implies that housing price and its expenditure share move in the same direction.

and purchase b_t. Instead, it requires government provision of social benefits.

The household's choice is subject to the following budget constraint:

$$c_t + R_{h,t}h_t = w_t + \frac{\pi_{p,t}}{L_t}, \tag{6}$$

where $R_{h,t}$ denotes the price for housing services and $\frac{\pi_{p,t}}{L_t}$ is the profit received by the household from the non-SOEs firms. Since there is no saving decision, each household maximizes its period utility given its budget constraint in each period.

3.1.3 Government

The government cares about the utility of households and the total production of SOEs:

$$W(U(c_t, h_t, b_t), Y_{s,t}) = \ (1-\phi_g)U(c_t, h_t, b_t) + \phi_g(Y_{s,t})^{\nu}, \tag{7}$$

where $0 < \phi_g < 1$ is the weight given to the total production of SOEs. The government and households have a common discount rate ρ. In Section 2 we discussed the instrumental role played by SOEs in achieving the policy goals of the Chinese government. Hence, we include $Y_{s,t}$ in the government's objective function as a simple mechanism to reflect the close relationship between SOEs and the government.

The land is owned by the government. Based on China's experience we assume that initially the government delegates the management authority of land to SOEs who are actual suppliers in the land market.[24] The land revenue received by SOEs belongs to the government. We assume that it is easy for SOEs to resell land to their workers.[25] The government

[24]This assumption is consistent with the discussion in Section 2 on land supply in China.

[25]This is consistent with experience of China. Between 1979 and 1998, SOEs and other public agencies were the main employers of urban workers and often provided housing services as part of the benefits to their employees (Yan et al., 2014). According to Compilation of Manual Summary Data of the First Nationwide Urban Housing Census (1986), most urban residents (the average is 78% and the median is 82%) lived in

is not able to prevent this kind of re-trading activities when there is a large number of SOEs. We further assume that the cost to monitor re-selling of land by SOE workers to non-SOE workers is sufficiently high.[26] Because residential housing units are not suitable for industrial use, we assume that non-SOEs are not able to purchase land from households. Hence, even though the government is not able to impose different land taxes (which manifests as different land prices in our model) between households and SOEs, different land prices between SOEs/households and non-SOEs are possible. However, there is a cost for the government to prevent profitable reselling induced by such price disparity.

For simplicity, we assume that the government uses land revenues to provide social benefits and balance its budget[27]:

$$R_{s,t}N_{s,t} + R_{p,t}N_{p,t} + R_{h,t}h_tL_t + \pi_{s,t} - \Psi(x_t) = B_t. \tag{8}$$

Here $\pi_{s,t}$ denotes the profit received from SOEs. $R_{s,t}$ (which is equal to $R_{h,t}$) and $R_{p,t}$ denote the land price for SOEs/households and non-SOEs, respectively. $N_{s,t}$, $N_{p,t}$ and h_tL_t is the amount of land used by SOEs, non-SOEs and households, respectively. $\Psi(x_t) = x_t^{\kappa} - 1$ represents the cost to implement price disparity, which is a strictly increasing in the relative land price, x_t, such that $x_t \geq 1$.[28]

In each period, the government needs to determine the relative land prices for SOEs/households

houses provided by SOEs and only 11% urban residents lived in non-public houses. In addition, Pudney and Wang (1995) used data for Liaoning and Sichuan provinces over the period 1986-90 and documented that a large majority of sampled households were public tenants in 1990.

[26]This assumption can be rationalized by noting that the housing market for non-SOE workers was very small before 2000 (Yan et al., 2014). In addition, Sato (2006) used 1999 CASS (Chinese Academy of Social Sciences) survey and showed that 79% of migrant households (who work mainly in non-SOEs) lived in rented housing and the primary source of rented housing was from urban households (who worked mainly in SOEs).

[27]Here we are assuming financing of public goods and social benefits as an outlet for the government's land revenues. This is an abstraction and it is reasonable to argue that a part of the land revenues could be siphoned away via corruption among government officials.

[28]We define $x_t = \max\left\{\frac{R_{p,t}}{R_{h,t}}, \frac{R_{h,t}}{R_{p,t}}\right\}$.

and non-SOEs. In particular, when there are SOEs in the economy, the relative land price for SOEs/households and non-SOEs is set by the government to provide the protection to SOEs against competition from non-SOEs . When there are no SOEs in the economy, the government needs to determine the relative land price for households and non-SOEs, which is used to raise land revenues from the households and promote economic growth. The above decisions also affect the timing of entry of non-SOEs in the goods market and the timing of stopping the protection of SOEs, which will be endogenously determined in our model.

3.2 Equilibrium

An equilibrium is defined such that:

[i] Given the paths of land prices and wages, households maximize utility, firms maximize profits;

[ii] Government maximizes its objective function given the best responses of agents to the land pricing; and

[iii] All markets clear:

$$h_{_t}L + N_{p,t} + N_{s,t} = N,$$

$$L_{p,t} + L_{s,t} = L_t,$$

$$c_t L_t + b_t L_t + \Psi(x_t) = Y_{s,t} + Y_{p,t}.$$

To find the equilibrium, after solving the utility maximization problem of households and the profit maximization problem of firms, we focus on the government's decisions on relative land prices set for SOEs/households and non-SOEs, or equivalently, the decisions on $N_{s,t}$, $N_{p,t}$ and h_t. In each time period, the maximization problem of the government that leads to the equilibrium allocation is defined in the appendix A.3.

Given $A_{s,0} = A_{p,0}$, it is easy to show that initially the optimal decision of the government is to set a land price high enough to deter the entry of non-SOEs in order to protect the less efficient SOEs. The rising non-SOEs productivity would eventually induce the government to allow the entry of non-SOEs to promote efficiency and raise output. Finally, at a sufficiently high level of non-SOE productivity, the government would abandon the dual-track pricing and without protection the inefficient SOEs exit the market. Therefore, our model generates three different regimes in the following order: (1) block the entry of non-SOEs; (2) allow non-SOEs to enter into the market while still protecting SOEs; (3) do not protect those inefficient SOEs.[29] The timing of the regime switch is endogenously determined. When the productivity of non-SOEs is relatively low (even if it is higher than that of SOEs), the government will impose a land tax, which is "epsilon" higher than $\tau_{p,t}$ (defined below), on non-SOEs:

$$\frac{R_{s,t}}{R_{p,t}} = \frac{R_{s,t}}{R_{s,t} + \tau_{p,t}} = \left(\frac{A_{s,t}}{A_{p,t}}\right)^{\frac{1}{1-\alpha}}. \tag{9}$$

By doing so, the government avoids the reduction of SOEs' production by preventing non-SOEs from entering into the market. This is *regime 1* in our model. As non-SOEs become much more productive than SOEs, the increase in output through the introduction of non-SOEs, which benefits households and raises the value of land, could eventually dominate the cost in terms of the output reduction of SOEs. Hence, with the rising relative productivity of non-SOEs the government will have an incentive to allow non-SOEs to enter the market. However, given the still dominant share of SOEs in the production of consumption good, the government also has an incentive to protect SOEs and set a lower land price for them when compared to non-SOEs. We call this *regime 2* that is characterized by a dual-track

[29]Note that Regime 2 may not exist under certain parametrization of the relative productivity of non-SOEs.

pricing in the land market with households and SOEs who pay the same land price whereas the non-SOEs pay a relatively higher land price, defined in Equation (9). As the relative productivity of non-SOEs continues to grow, household's income rises, the size of SOEs and its share in the production of good decline, and the cost to implement dual-track pricing rises. Hence, at some point, the government will abandon the policy of protecting inefficient SOEs and consolidate its monopoly in the land market. This is called *regime 3* in our model. In our model, household's demand for housing services is inelastic[30] whereas firm's demand for land input is elastic.[31] Hence, the government will charge households a higher land price than non-SOEs in *regime 3* to raise revenues from households via higher land prices and to encourage growth by providing land to the non-SOEs at lower prices.[32]

In terms of labor share dynamics, labor share will decline over time in *regime 1* given that (1) $R_{h,t}$ rises with $R_{s,t}$, (2) household's demand for housing services is inelastic, and (3) labor share is higher in the consumption good sector than in the housing sector. In *regime 2*, our model is flexible enough to generate either a rising or declining trend in labor share, depending on the relative productivity growth of non-SOEs. In *regime 3* we will observe an accelerated decline in labor share. Similar to *regime 1*, our model would generate a declining trend in labor share even if there is no price discrimination between non-SOEs and households in *regime 3*. However, given the government's objective function, households will be charged a higher land price than non-SOEs in *regime 3*, and hence spend an even bigger share of their income on housing services. This additional channel accelerates the decline of labor share in *regime 3* of our model.

[30]Murray and Sun (2015) find that the price elasticity of demand for housing services in China between 1991 and 2006 is -0.64.

[31]Our paper models the economy at the national level, so the mobility of industrial firms across regions is not incorporated in our framework. We find that firms are more price sensitive than households even in the absence of such mobility. Given that firms are more mobile than households, adding firm mobility to our framework will further amplify the response of firms to the land price policy changes.

[32]This is also consistent with the experience of China where local government compete for industrial investment and use lower land prices for industrial use as an incentive.

3.3 Calibration

We calibrate the preference and technological parameters of the model to match key features of the Chinese economy during 1978-2010. Table 1 provides the key data moments and their corresponding values that we target in our calibration exercise. It is important to note that we do not target land prices and instead use our calibrated model to quantify the fraction of rise in relative land prices that can be accounted for by our model.

The data in Table 1 provide eight observations that can be used to pin down parameter values. Normalizing the initial stock of land and labor input to be 1, the model has 10 parameters to be determined. The labor share parameter α is set to be 0.5, which is consistent with the one used in Brandt and Zhu (2010). The growth rate of labor input is set to be equal to that of working population, obtained from China Statistical Yearbook. This leaves the following eight parameters that needs to be calibrated: two share parameters (ϕ_1 and ϕ_2) and one elasticity parameter (ζ) in preferences , one share parameters ϕ_g and one power parameter ν that captures the relative importance of SOEs production in the government's objective function, one cost parameter κ associated with the implementation of price disparity, and the productivity growth rate of SOEs and non-SOEs γ_s and γ_p. These parameters are chosen to match eight moments listed in Table 1.

In order to understand the role of different parameters in achieving the targets in data, we provide a brief discussion of the calibration procedure starting with the parameters primarily determining the employment and output shares of non-SOEs. Our model can potentially generate three different policy regimes. In *regime 1*, SOEs are fully protected, and non-SOEs do not find it profitable to enter the market. In *regime 2*, non-SOEs are allowed to enter the market to compete with SOEs. In *regime 3*, SOEs in the consumption good sector are completely replaced by non-SOEs. The duration of each policy regime and the intensity of competition between SOEs and non-SOEs depend on the relative importance of SOEs in the social welfare function (ϕ_g and ν) and the cost of protection (κ), which can help pin down

the initial employment and output shares of non-SOEs. The labor income shares are 0 and α in the housing sector and the consumption good sector, respectively. The share parameter ϕ_1 affects the expenditure on housing services and consumption good, which can help pin down the initial labor income share. ϕ_2 describes the relative importance of social benefit in preferences, which can influence the growth in government expenditures on social benefits. The elasticity of substitution between consumption good and housing services ($\frac{1}{1-\zeta}$) can help determine the dynamic in housing price and its expenditure share. In addition, we choose γ_s and γ_p to match the growth in real GDP during the whole sample period and the growth in per-capita consumption during 2000-2010. γ_p plays the most important role to determine the consumption growth in *regime 3*, so we target the consumption growth in the ending period.

Table 2 reports the calibrated values of these parameters consistent with matching the data moments listed in Table 1. Note that the calibrated value of ζ is negative, which implies that housing services and consumption good are gross complements. The TFP growth rate is substantially larger in non-SOEs than in SOEs, which is consistent with the Chinese experience. Finally, our calibrated model is able to generate three policy regimes: 1978-1988, 1989-1998, and 1999-2010.

4 Main Predictions from the Calibrated Model

In this section we use our calibrated model to explain the evolution of land prices, labor share, income, and government expenditure in China in response to the exogenous forces in our model, namely the rising relative productivity of the non-SOEs.[33] For this purpose we solve our model numerically as a sequence of static optimization problems using the calibrated parameter values reported in Table 2. We provide the details on the model solution in

[33]Note that in our calibration exercise, neither land prices nor the changes in labor share, income and government expenditure across the three policy regimes are targeted.

Appendix A. Figures 4-10 present the main predictions of the model, and in Table 3 we present the summary statistics for different time periods for relative land prices, labor share, real government expenditure, and real GDP. In each case we contrast the model predictions with the observed pattern in data.

4.1 Land Prices

In this subsection we analyze the performance of our model in capturing the land price dynamics observed in China. From Figure 1 two salient features emerge about the land prices in China since 2000. First, land prices have increased rapidly and residential users pay substantially higher land price than industrial users. Second, there is a an increasing disparity in these two prices. Our model is able to capture both of these facts. In Figure 4, we plot the evolution of relative land price ($\frac{R_{h,t}}{R_{p,t}}$) from our model. In the same figure, we also provide the actual price data and quality-adjusted price data for residential uses relative to industrial uses. We observe that our model does a good job in capturing the underlying rising trend in the disparity in land prices between residential and industrial uses. After the policy switches to *regime 3*, the land price paid by households is above that paid by the non-SOEs and rising. Such price discrimination is empirically consistent with the experience of the Chinese economy as documented in Figure 1. From Table 3, we find that our model is able to explain 56% of the total increase in the relative land price during 2000-2010. Note that in recent years, households in China tend to purchase apartments/houses in urban areas whereas firms tend to purchase land in suburban areas (Gao and Liu, 2014). Although our model does not capture this geographic dimension, it is still able to explain more than half of the relative price increase observed in China during 2000-2010. We also estimate a Hedonic pricing model to remove some of the quality differences from actual land price data and find that our model is able to explain more than 70% of the total increase in

the quality-adjusted relative land price during 2007-2010.[34] In terms of timing of the price discrimination between households and firms, our calibrated model predicts that the land price paid by household will differ from that paid by firms only after 2003. This prediction coincides with *Decree No. 71*, issued by Ministry of Land and Resources in 2004, which stipulates that municipal governments will be the only supplier of land for commercial and residential uses in urban areas. This granted local governments sufficient market power to practice price discrimination between different users in the land market.

In Figure 5 we plot the evolution of land prices across the three regimes in our model. At lower level of productivity, the land price paid by non-SOEs, as indicated by solid black line, lies above the price paid by households in Regime 2.[35] However, in *regime 3*, we observe that our model predicts a rapid rise in the land price paid by households, which is qualitatively consistent with the actual situation in China. In addition, an important feature of our model that influences the policy incentives of the government at different levels of non-SOE productivity is the cost of implementing price disparity. In Figure 6 we plot the cost of implementing price disparity during 1978-2010 and observe that this cost is rising with the relative productivity of non-SOEs. Finally, in Figure 7 we present the distortion caused by the government's land price policy in land use. We find that in *regime 3*, the government policy distorts the land market by incentivizing industrial use over residential use. This is also consistent with the experience of China since 2000 when a large part of urban land is devoted to industrial use while residential land supply has been reduced substantially.

Finally, in Figure 8, we plot the evolution of the price elasticity of housing from our calibrated model. The annual average house price elasticity from our model during 1991-2006 is -0.6992. For the same time period, Murray and Sun (2015) used the Chinese Health and

[34]For example, we used permitted floor area ratios, floor areas, and distance to central business districts to capture quality differences. See Appendix B for details on our Hedonic price analysis.

[35]Note that in our model, in the first two regimes, the SOEs pay the same price as households. Also, in the first regime, there are no non-SOEs.

Nutrition Surveys and estimated this elasticity parameter to be -0.64. Hence, our calibrated model does a reasonable job of matching this elasticity parameter in data.

4.2 Labor Share

An important implication of the housing price dynamics in our model is for the evolution of the labor share across the three policy regimes. In recent years many studies have questioned the stability of labor shares. For instance, Rodriguez and Jayadev (2010) used United Nations Industrial Development Organization (UNIDO) database for 129 countries to document declining trend in labor shares since the 1980 in most countries in their sample. Karabarbounis and Neiman (2014) provide cross country evidence for significant decline in labor shares since the early 1980s. They find that between 1975-2012, 71 percent of the countries in their sample witnessed declining trend in labor shares. Many factors have been identified for such a decline ranging from capital augmenting technological progress, globalization, and demographic change (Harrison, 2005; Guscina, 2006; Jaumotte and Tytell, 2007; Schmidt and Vosen, 2013). Karabarbounis and Neiman (2014) underscore the importance of the price of investment good in labor share dynamics and argue that this factor alone can explain approximately half of the observed decline in the labor share since early 1980s, after controlling for other factors identified in the literature.

The labor share of income in China is much lower when compared with advanced nations, and post 1995 it has witnessed sharpest decline among the top ten economies (Karabarbounis and Neiman, 2014). Luo and Zhang (2010) find that foreign direct investment and privatization played an important role in explaining the decline in labor share in China post 1995. Huang and Xu (2009) attribute the decline in labor share to capital augmenting technological change. Minami and Hondai (1995) study the enterprise reforms of China and attribute the over time variation in labor shares to changes in the government wage policies over time. Bai and Qian (2010) provide one of the most comprehensive examination of labor share dynamics

in China. They argue that the official estimates overstates the decline in the labor share due to a change in accounting method between 2003 and 2004. However, even after adjusting the official estimates, they found that the labor share in China dropped by 7.2 percentage points between 1995 and 2007. They attribute this decline in part to the structural transformation of China from an agrarian to an industrial economy. They also found significant within-sector component dominated by a decline in the labor share in the industry sector post 1995. They found that most of this decline was due to restructuring of the SOEs and the rise in monopoly power. They did not find an important role for relative price of capital and capital augmenting technological change in explaining the decline in labor share during this period.

An important aspect of the labor share dynamics in China is the non-monotonic pattern with initially rising shares followed by a decline and a subsequent acceleration in this decline in recent years (see Figure 3). This hump-shaped pattern has not been quantitatively examined in the existing literature. Although the decline in labor share due to rising productivity has already been studied in the literature, such a mechanism alone cannot explain the initially rising labor share observed in China and also the acceleration in the decline in labor share observed since early 2000s. We propose a mechanism, the land price policy, that explains both of these facts and in this way we contribute to the literature on labor share dynamics. In Figure 9 we plot the predicted labor share in our model along with the data on labor share. We also superimpose linear trends computed for the three segments of the period of observations: 1978-88, 1989-98, and 1999-2007. Since we do not model the reforms in the agricultural sector and early reforms of SOEs, our model is unable to capture the initial rise in the labor share observed in data during 1978-88. In *regime 2*, characterized by dual-track pricing and rising non-SOEs' relative productivity, our model predicts a rising trend in labor share. Thereafter, in *regime 3*, characterized by price discrimination with higher relative land price for households compared to firms (non-SOEs), we find a steep decline

in the labor share. In our model, the ratio of land prices paid by households and non-SOEs is an increasing function of the relative productivity of non-SOEs, which exacerbates the decline of the labor share that is associated with rising productivity in *regime 3*. Table 3 shows that our model can explain 47.4% of the increase in the labor share observed during 1989-98 and 45.4% of the decrease in the labor share observed during 1999-2007. These findings underscore the importance of accounting for the role played by domestic policy environment in shaping the functional distribution of income.

4.3 Income and Government Expenditure

Finally we present the results for income (GDP) and government expenditure on public goods and social benefits from our calibrated model. Figure 10 presents the evolution of real government expenditure on public goods and social benefits in our model and the actual data during 1978-2010. Our model predicts a sharp increase in the government expenditure post 2000, which matches the trend observed in data. From Table 3 we can observe that annual growth rate for real government expenditure during 1999-2006 (regime 3) is 11.53% compared to the 15.98% observed in data. Hence, our model is able to explain roughly 72% of the increase in real government expenditure since 1999. China has seen a rapid expansion provision of public goods and social benefits since 1999 and our model's prediction is consistent with the stylized fact. Figure 11 presents the model's prediction about real GDP along with data. Our model under predicts the income growth observed in data between 1978-1998 (first two regimes) and then predicts relatively faster rate of growth post 1999 when compared to that observed in data.

4.4 Laissez-Faire Economy

In this subsection we highlight the role played by the land price policy we incorporate in our theoretical framework in driving land prices and labor share dynamics. For this purpose we study the case of a Laissez-Faire economy with no government intervention in the land market. Without government protection, rising productivity of non-SOEs would mean that inefficient SOEs eventually exit the consumption good market. As before in equilibrium, non-SOEs maximize profits and households maximize utility. We close the model by assuming that the government balances its budget by using land revenues to provide social benefits, and the government maximizes the objective function given by equation (7). We solve the Laissez-Faire version of our model using the same calibrated parameter values as those listed in Table 2. Figures 12-14 present the main predictions and for comparison we also plot the predictions from our original theoretical framework with the government's intervention in the land market. From Figure 11 we observe that land prices are rising but there is no difference in prices paid by different users. This is inconsistent with the observed behavior of land prices in China with residential users paying a much higher price in recent years when compared to industrial users. From Figure 12 we can observe that the labor share will decline monotonically with rising non-SOEs' relative productivity. This is in sharp contrast to the findings from our original model where labor share displayed a non-monotonic pattern that matches the observed labor share dynamics in China. Finally, Figure 13 plots the prediction for government expenditure under the Laissez-Faire assumption. Not surprisingly, the rise of the government's expenditure on public goods and social benefits in recent years is less steep compared to that observed in our original model.

5 Conclusion

Using a two-sector model economy with exogenously rising relative productivity of non-SOEs, we rationalize the introduction of non-SOEs and reform of land market since 1980s, and the reform of SOEs which is characterized by the retreat of SOEs in the competitive manufacturing sector, and the establishment of state monopoly in the land market from late-1990s. Our model generates a regime switch in the land price policy in China: from a dual-track pricing aimed at protecting inefficient SOEs to a discriminating policy that aimed at encouraging economic growth and raising land revenue from private households. At low levels of relative non-SOEs productivity and household incomes, the government policy is to protect the SOEs from competition and hence set a higher price for non-SOEs. On the other hand, rising productivity and household incomes incentivize the government policy to price discriminate between households and non-SOEs. To raise revenues via private housing markets, the government exercises its monopoly power at high level of income to charge a higher land price for residential use.

In our theoretical framework, we model four important driving forces to capture the zhuada fangxiao reform as the retreat of the SOEs from the competitive manufacturing sector and the establishment of market power in the profitable land (factor) market. First, less efficient SOEs are not able to compete with non-SOEs in the competitive manufacturing sector. Second, with rising non-SOEs productivity, protecting SOEs becomes more and more costly and prevents the government from becoming a monopoly in the land market. Third, abandoning the protection of SOEs and encouraging higher productivity of non-SOEs can achieve higher economic growth. Fourth, as households become richer, a monopoly in the land market will allow the government to raise much more land revenue from households.

We calibrate our model to match key economic data for China during 1978-2010. We find that our model can explain more than half of the increase in the land price disparity between

industry use and residential use observed in China since 2000. We are also able to explain rapid rise in land price and housing price that have been observed in China since 2000. An important implication of our model is for labor share dynamics. Our model predicts a rising labor share between 1989 and 1998 and a steep decline in this share post 1999. Such a pattern is evident from labor share data for China. Although productivity driven labor share decline has been documented in many studies in the literature, our model is able to capture the non-monotonic labor share pattern implying the domestic policy environment can play an important role in determining the factor shares in the economy.

Although our model provides a simple framework that captures the salient features of China's economic reform process, the evolution on land price policy, and interaction between policy incentives and changing nature of the economy, there are many important aspects of the economic reform process that we did not capture in our model. For instance, during 1978-1995, there were important reforms of the agricultural sector followed by early reforms of the SOEs aimed at improving managerial efficiency, among other things. Similarly, the fiscal reform of 1994 was one of the important motivation for the government to raise land revenue. Our model does not explicitly capture these reforms. Furthermore, because there is no capital in our model, we abstract away from the practices of local governments to use land as a collateral for borrowing investment funding from bankers to promote economic growth (Lu and Sun, 2013). Finally, our model does not capture other forms of SOEs protection (for instance, subsidies), and the wage difference between non-SOE workers and SOE workers due to the benefits associated with the *"hukou"* system. We hope that these important issues will spur an active future research agenda for researchers interested in understanding the economic reform process of China, and that our paper will provide a reasonable starting point for such analyses.

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Table 1: **Data Moments for Calibration Exercise**

Moment	**Value in Data**
Average employment share of non-SOEs (1978-1984)	0
Average employment share of non-SOEs (1985-1990)	0.0696
Average output share of SOEs (1978-1990)	0.968
Average labor income share (1978-1990)	0.426
Average annual growth in government expenditures (1978-2006)	10.1%
Average annual growth in housing expenditure share (1985-2010)	0.0362
Average annual growth in real GDP (1978-2010)	9.95%
Average annual growth in per-capita consumption (2000-2010)	8.47%

Data sources and other notes:
(1) Labor income share is obtained from Zhang and Zhang (2010).
(2) Rest of the data are obtained from various years of China Statistical Yearbook and National Bureau of Statistics of China (2010)
(3) When we calculate the employment and output share data, SOEs consist of "state-owned units" and "collective-owned units."
(4) According to the 2008 China Statistical Yearbook, there are substantial adjustments in the classifications of revenue and expenditure accounts in 2007, so the data on the different classifications of government expenditures before 2007 are not comparable to the those from the latter years. In addition, in order to better match the model (which focuses on government expenditures on public goods and social benefits) with data, we subtract the following items from government expenditures when we compute its average growth rate during 1978-2006: expenditure for capital construction, additional appropriation for circulating capital of enterprises, innovation funds and science and technology promotion funds, and expenditure on policy-related subsidies.
(5) In our model, we only consider the expenditure on consumption good and housing services. Housing expenditure is in a broader definition than the one from actual data. In order to better match the model with the data, we consider the following items as housing expenditure: residence, transport and communications, and education, culture and recreation. The housing expenditure data are not available before 1985.
(6) In the model, we consider both $\Psi(x_t)$ and B_t as the government expenditures on public goods and social benefits. $\Psi(x_t)$ reflects the implementation costs of government's land policy, which is considered as a part of public goods when we match the model with the data.

Table 2: **Calibrated Parameter Values**

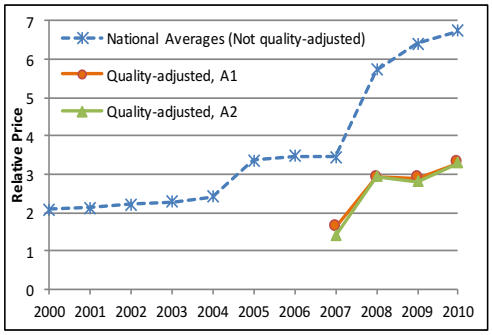
Parameters	Calibrated Values
ϕ_g	0.5177
ν	0.1539
κ	0.4743
ϕ_1	0.7035
ϕ_2	0.7607
ζ	-1.5228
γ_s	0.0030
γ_p	0.0805
Regime 1: 1978-1988	
Regime 2: 1989-1998	
Regime 3: 1999-2010	

Table 3: **Model Predictions**

	Model	Data	% Explained
Total Increase in Relative Land Price, Residential/Industry			
2000-2010	2.59	4.67	55.5
Quality-adjusted A1		1.67	84.4
Quality-adjusted A2		1.89	74.5
Annual Growth Rates of Labor Share:			
1978-1988	-0.080%	0.918%	-
1989-1998	0.186%	0.39%	47.4
1999-2007	-0.784%	-1.73%	45.4
Annual Growth Rates of Real Government Expenditure:			
1978-1988	1.38%	6.30%	21.9
1989-1998	5.69%	8.70%	65.4
1999-2006	11.53%	15.98%	72.2
Annual Growth Rates of Real GDP:			
1978-1988	1.32%	10.09%	13.1
1989-1998	5.8%	10.05%	58.1
1999-2010	11.02%	10.17%	108.4

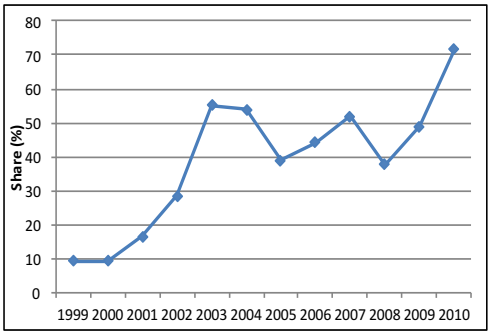
Notes: The calculation of quality-adjusted relative land prices (A1 and A2) is provided in Appendix B.

Figure 1: Relative Land Price by Use – Residential/Industrial



(Source*: Ministry of Land and Resources of China*. The calculation of quality-adjusted relative land price is provided in Appendix B.)

Figure 2: The Share of Land Grant Premiums in Local Fiscal Revenues



(Source: the China Land and Resources Statistical Yearbook and China Statistical Yearbook. We thank Professor Xiaohu Huang for providing those data sets to public users.)

Figure 3: Labor Share of Income

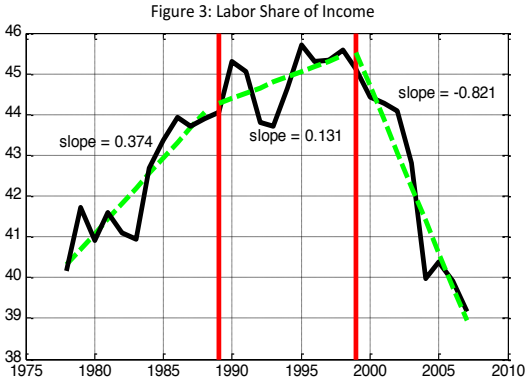


Figure 4: Relative Land Price

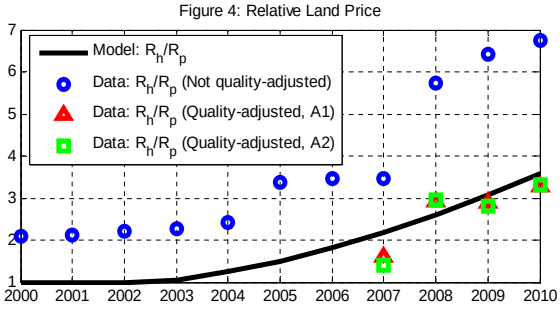


Figure 5: Land Price Dynamics

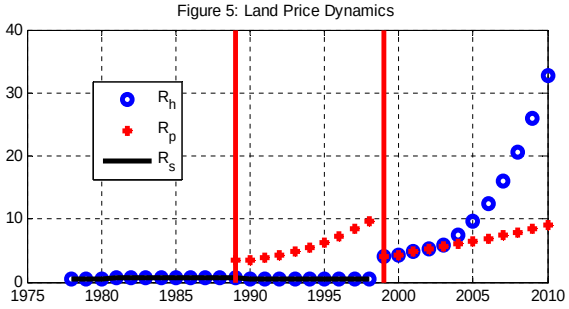


Figure 6: Cost of Price Discrimination

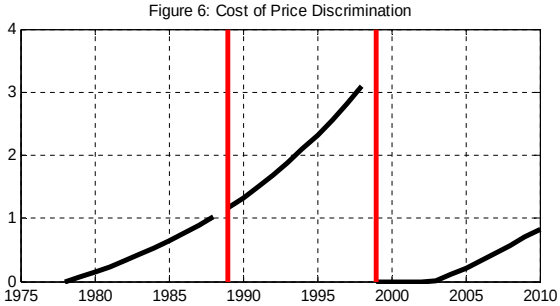


Figure 7: Land Use

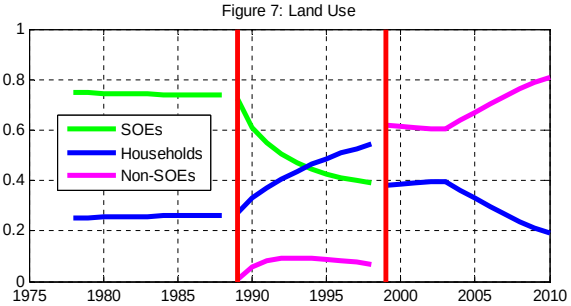


Figure 8: Price Elasticity of Housing Services Demand

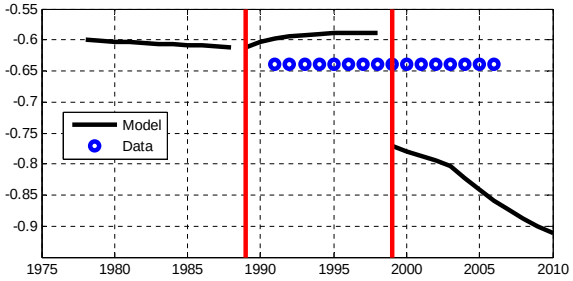


Figure 9: Labor Share Dynamics

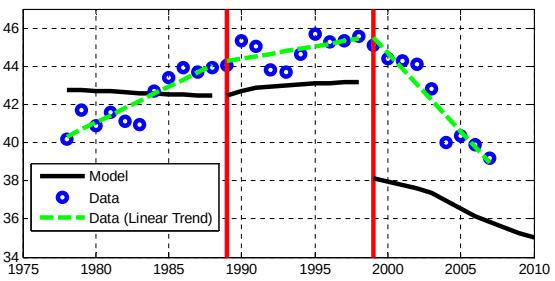


Figure 10: Real Government Expenditures on Public Goods and Social Benefits

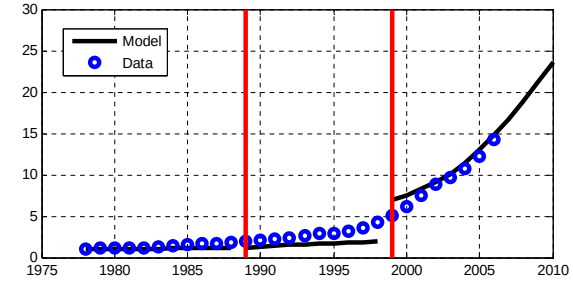


Figure 11: Real GDP

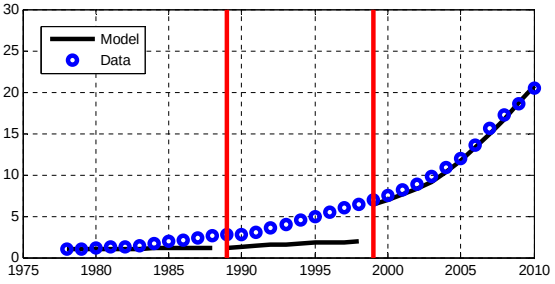


Figure 12: Land Prices

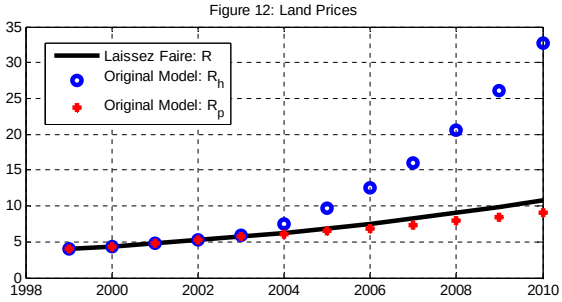


Figure 13: Labor Share

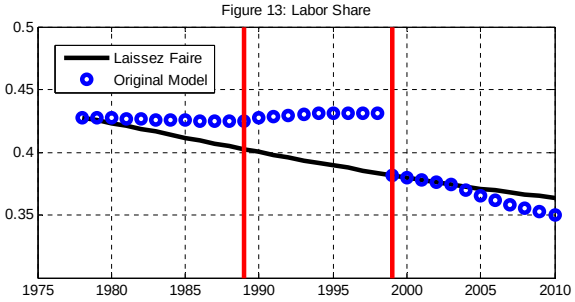
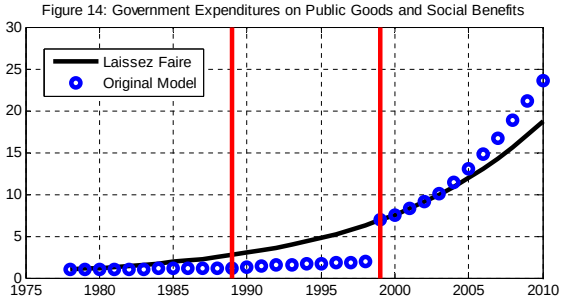


Figure 14: Government Expenditures on Public Goods and Social Benefits



A Appendix: Solving the Model

A.1 Consumer's Problem

$$\max_{c_t,h_t} \ \phi_2 \left[\phi_1 \left(c_t\right)^{\zeta} + (1-\phi_1)h_t^{\zeta}\right]^{\frac{1}{\zeta}} + (1-\phi_2)b_t,$$

s.t.

$$c_t + R_{h,t}h_t = w_t + \frac{\pi_{p,t}}{L_t}.$$

F.O.C.s:

$$[c_t] : \phi_2\phi_1 \left[\phi_1 \left(c_t\right)^{\zeta} + (1-\phi_1)h_t^{\zeta}\right]^{\frac{1-\zeta}{\zeta}} \left(c_t\right)^{\zeta-1} = \lambda_t.$$
$$[h_t] : \phi_2(1-\phi_1) \left[\phi_1 \left(c_t\right)^{\zeta} + (1-\phi_1)h_t^{\zeta}\right]^{\frac{1-\zeta}{\zeta}} \left(h_t\right)^{\zeta-1} = \lambda_t R_{h,t}.$$

$$\Rightarrow \frac{\phi_1}{1-\phi_1}\left(\frac{c_t}{h_t}\right)^{\zeta-1} = \frac{1}{R_{h,t}} \Rightarrow h_t = \left(\frac{1-\phi_1}{\phi_1 R_{h,t}}\right)^{\frac{1}{1-\zeta}} c_t.$$

Given the budget constraint, $c_t = \frac{w_t + \frac{\pi_{p,t}}{L_t}}{1+R_{h,t}\left(\frac{1-\phi_1}{\phi_1 R_{h,t}}\right)^{\frac{1}{1-\zeta}}}$.

A.2 Firm's Problem

1) SOEs' Maximization:

$$\max_{N_{s,t},L_{s,t}} A_{s,t}N_{s,t}^{1-\alpha}L_{s,t}^{\alpha} - R_{s,t}N_{s,t} - w_t L_{s,t}.$$

F.O.C.s:

$[N_{s,t}] : R_{s,t} = (1-\alpha)A_{s,t}N_{s,t}^{-\alpha}L_{s,t}^{\alpha}.$

$[L_{s,t}] : w_t = \alpha A_{s,t}N_{s,t}^{1-\alpha}L_{s,t}^{\alpha-1}.$

2) Non-SOEs' Maximization:

F.O.C.s:

$$\max_{N_{p,t},L_{p,t}} A_{p,t}N_{p,t}^{1-\alpha}L_{p,t}^{\alpha} - R_{p,t}N_{p,t} - w_tL_{p,t}.$$

$[N_{p,t}] : R_{p,t} = (1-\alpha)A_{p,t}N_{p,t}^{-\alpha}L_{p,t}^{\alpha}.$

$[L_{p,t}] : w_t = \alpha A_{p,t}N_{p,t}^{1-\alpha}L_{p,t}^{\alpha-1}.$

If both SOEs and non-SOEs exist, $\frac{R_{s,t}}{R_{p,t}} = \left(\frac{A_{s,t}}{A_{p,t}}\right)^{\frac{1}{1-\alpha}}$.

A.3 Government's Problem

In each period the equilibrium allocation is given by the solution to the government's optimization problem described below:

$$\max_{R_{h,t},R_{p,t},} (1-\phi_g)\left\{\phi_2\left[\phi_1\left(c_t\right)^{\zeta} + (1-\phi_1)h_t^{\zeta}\right]^{\frac{1}{\zeta}} + (1-\phi_2)b_t\right\} + \phi_g(Y_{s,t})^{\nu},$$

s.t.

$$R_{s,t}N_{s,t} + R_{p,t}N_{p,t} + R_{h,t}h_tL_t + \pi_{s,t} - \Psi(max\left\{\frac{R_{p,t}}{R_{h,t}},\ \frac{R_{h,t}}{R_{p,t}}\right\}) = b_tL_t, \tag{10}$$

$$h_t = \left(\frac{1-\phi_1}{\phi_1 R_{h,t}}\right)^{\frac{1}{1-\zeta}} c_t, \tag{11}$$

$$c_t = \frac{w_t + \frac{\pi_{p,t}}{L_t}}{1 + R_{h,t}\left(\frac{1-\phi_1}{\phi_1 R_{h,t}}\right)^{\frac{1}{1-\zeta}}}, \tag{12}$$

$$\left(R_{s,t} - R_{h,t}\right)N_{s,t} = 0, \tag{13}$$

$$\left[R_{s,t} - (1-\alpha)A_{s,t}N_{s,t}^{-\alpha}L_{s,t}^{\alpha}\right] N_{s,t} = 0, \tag{14}$$

$$\left[w_t - \alpha A_{s,t}N_{s,t}^{1-\alpha}L_{s,t}^{\alpha-1}\right] N_{s,t} = 0, \tag{15}$$

$$\left[R_{p,t} - (1-\alpha)A_{p,t}N_{p,t}^{-\alpha}L_{p,t}^{\alpha}\right] N_{p,t} = 0, \tag{16}$$

$$\left[w_t - \alpha A_{p,t}N_{p,t}^{1-\alpha}L_{p,t}^{\alpha-1}\right] N_{p,t} = 0, \tag{17}$$

$$\pi_{s,t} = A_{s,t}N_{s,t}^{1-\alpha}L_{s,t}^{\alpha} - R_{s,t}N_{s,t} - w_t L_{s,t} \geq 0, \tag{18}$$

$$\pi_{p,t} = A_{p,t}N_{p,t}^{1-\alpha}L_{p,t}^{\alpha} - R_{p,t}N_{p,t} - w_t L_{p,t} \geq 0, \tag{19}$$

$$L_t c_t = A_{s,t}N_{s,t}^{1-\alpha}L_{s,t}^{\alpha} + A_{p,t}N_{p,t}^{1-\alpha}L_{p,t}^{\alpha} - L_t b_t - \Psi(max\left\{\frac{R_{p,t}}{R_{h,t}}, \frac{R_{h,t}}{R_{p,t}}\right\}, \tag{20}$$

$$N_{s,t} + N_{p,t} + h_t L_t = N, \tag{21}$$

$$L_{p,t} + L_{s,t} = L_t, \tag{22}$$

$$Y_{s,t} = A_{s,t}N_{s,t}^{1-\alpha}L_{s,t}^{\alpha}. \tag{23}$$

Equation (10) is the budget constraint of the government. Equations (11)-(12) ensure that the households' utility is maximized given land price for households and wage, which are necessary and sufficient if utility function is strictly concave. Equations (13) comes from the assumption that households and SOEs pay the same land prices when there are SOEs in the economy. Equations (14)-(15) ensure that the SOEs' profit is maximized when there are SOEs in the economy, given land price for SOEs and wage. Similarly, equations (16)-(17) imply that non-SOEs' profit is maximized when non-SOEs exist in the goods market, given land price for non-SOEs and wage. Equations (18)-(19) imply that the profits of SOEs and non-SOEs are not negative. Equation (20) is the market clearing condition for the

consumption good. Equations (21)-(22) are market clearing conditions for land and labor, respectively. Equation (23) is the output of SOEs.

B Appendix: Hedonic Price Model

We apply the Hedonic price framework of Kainab and Quigley (1970) to compute quality-adjusted relative land prices. The individual land price data are obtained from www.landvaluecom.cn and cover 73,018 industrial and residential land parcels, which were offered for sale by way of tenders, auctions and listing in 217 cities during 2004-2010. The Hedonic price equation is specified as follows:

(24)

$$\ln(P_{sci,t}) = \alpha_t Res_{sci,t} + \beta_{1s} FAR_{sci,t} + \beta_{2s} FA_{sci,t} + \beta_{3s} Auction_{sci,t} + \beta_{4s} Listing_{sci,t} + H_{c,t} + \epsilon_{sci,t}.$$

where $P_{sci,t}$ is the unit price of land parcel i sold in city c of province s in year t, $FAR_{sci,t}$ is the permitted floor area ratio, $FA_{sci,t}$ measures the floor area, $Auction_{sci,t}$ is a dummy indicator for land sold via auctions, $Listing_{sci,t}$ is a dummy indicator for land sold via listing, and $H_{c,t}$ refers to city-year fixed effects, which include the interaction terms between city and year dummies. We allow β to be provincial-specific.[36] $Res_{sci,t}$ is a dummy indicator, which is equal to 1 if it is for residential use and 0 otherwise. Then, $\exp(\alpha_t)$ captures the quality-adjusted price disparity between residential and industrial uses.

We use repeated cross-sectional data to estimate the Hedonic price equation (24). Due to the availability of transaction prices, the number of observations is reduced from 73,018 to 52,991. Due to the availability of control variables, the number of observations is further cut to 48,786. We delete one observation because its FAR is 6004 and delete another 43

[36] As a robustness check, we allow β to be city-specific. Our conclusions remain qualitatively the same.

observations because those land parcels have a dual function in both residential and industrial uses. In addition, we exclude the data between 2004 and 2006 because the annual number of industrial land parcels is less than 50. Consequently, the total number of observations is now 45,121. By comparing sample averages with national averages reported in Figure 1, it is clear that our land parcel data are not nationally representative, so we use the ratio of national averages to our sample averages to adjust $\exp(\alpha_t)$ as our quality-adjusted relative land prices, labeled as "A1" in Figure 1.

Furthermore, we control for the distance to central business districts (CBDs) by adding $\beta_{5s} Distance_{sci,t}$ into the Hedonic price equation (24). CBDs are constructed based on the locations of the First People's Hospital, Maternal and Child Health Center, Traditional Chinese Medicine Hospital, vaults at the branch office of the People's Bank of China, and the main office of Industrial and Commercial Bank of China in each city. We first compute the perimeter of a triangle formed by any three locations. Then, the center of the triangle with the shortest perimeter is considered to be the CBD of a city.

In order to apply mono-centric city model, we need to restrict our attention to the land parcels located in the main urban area of each city, so we drop land parcels located at the county-level cities, towns and villages, further reducing the number of observations to 25,067. To minimize the impacts of outliers, land parcels with a distance to CBDs at the upper 1% level are also excluded. Therefore, the total number of observations used to estimate the extended Hedonic price equation is 24,818. Again, we use the same correction method to compute quality-adjusted relative land prices, labeled as "A2" in Figure 1.