Increasing Returns, Land Use Controls and Housing Prices

Dingsheng Zhang, Wenli Cheng* and Yew-Kwang Ng

Abstract
The Chinese government has been active in trying to cool the alleged bubbles in its housing markets, especially in urban areas. This paper argues that the high housing prices are at least partly caused by some real factors, including the policy of restricting land uses, in particular the maintenance of a minimum overall agricultural acreage. A simple model of three sectors (housing, agriculture, and others) is constructed to examine the effects of the artificial constraint. The role of increasing returns in the non-agricultural sectors in exacerbating the policy biases is also examined. The model is then calibrated to estimate the effects of land use control policy on housing prices in China.

JEL classification: R31, R38

Keywords: increasing returns; land use controls in China; housing prices in China

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1. Introduction

Housing prices in China, especially in large urban cities, have risen substantially in recent years. Data from the Chinese Economic Information Network (www.cei.gov.cn) suggest that average housing price (per square meter) for the country as a whole increased by 85% between 1999 and 2008, or 7% per annum. Housing prices in major cities increased even more. For example, over the same period, average housing price in Beijing increased by 120% (or 9% per annum) and that in Shanghai increased by 140% (or 10% per annum). The rising price of housing has led to serious concerns about the potential of a housing bubble which may in time burst, causing significant damage to the economy. Amid such concerns, the Chinese government has introduced various policies in an attempt to cool down the allegedly overheated real estate market.

Whether there is a housing price bubble building up in China is debatable. One the one hand, while housing prices have risen rapidly in the last two decades, GDP has been rising at an even faster rate. As shown in Figure 1, between 1992 and 2009, nominal GDP growth significantly out-paced housing price growth in most years. On the other hand, housing affordability does seem to have declined although there are signs of improvement in recent years. According to Yang (2009), during the period 1998 to 2003 the house price to income ratio was relatively stable within the range of 6.1 to 6.4. The ratio rose sharply in 2004 to 6.9 and continued climb and peaked at 7.4 in 2007, but fell back to 6.8 in 2008.

This paper does not directly wade into the debate as to whether the urban real estate market in China is over-heated. Rather, starting from the empirical fact that housing prices have increased substantially, we attempt to investigate some of the “real” (as compared to monetary...
and speculative) factors that are behind the price rise in urban housing. In particular we focus on the possible effects of land use control policies on housing prices.

The development of a housing market in China has been a gradual (and on-going) process. From the beginning of economic reforms in 1979, it took about two decades for the country to move from government allocation of housing to a dual track system (in which market based allocation and government allocation co-existed) to market allocation of housing (Ye, Wu, & Wu, 2006). Although market forces are primary drivers of housing prices in China, the government continues to play a very important role because the government owns the land, and exercises significant control over its use. For example, as made clear by the Chinese Premier, Wen Jiabao, the Chinese government intends to maintain a minimum acreage of 1.8 billion mu (i.e., 120 million hectares) for agricultural use. As an important part of this policy, land classified as agricultural, even if close to large urban centres, is not allowed for commercial housing without special permission. This policy appears to have been successfully implemented. As shown in Table 1, agricultural land use between 2002 and 2010 was relatively stable at slightly above 120 million hectares. Setting aside possible political rationales for the policy of maintaining a minimum level of agricultural land use, it seems clear that the policy would have an unintended effect of raising housing prices. This paper develops a model to investigate this unintended effect.

A number of studies in the literature have considered the effects of land use controls on housing prices in different jurisdictions. For example, Hannah, Kim, & Mills (1993) suggests that for the period 1973-88, the rise in house prices in Korea resulted from the government's tendency to under-allocate land to urban residential use. Glaeser, Gyourko, & Saks (2005; 2006) show that in the US, artificial supply restrictions were a key driver for housing price increases
since 1970. Ihlanfeldt (2007) finds that more restrictive regulation increases house price and decrease land price in 100 Florida cities. Moran (2007) argues that strict State or Territory Government regulation on the supply of land for housing contributed to high land prices and housing costs in Australia. In the context of the Chinese housing market, some authors, for instances, Zhu (2005) and Zhang (2008), note that government’s land supply policy had a significant impact on housing prices. To our knowledge, however, no studies have formally investigated the effect of government land use policies on the Chinese housing market. This paper makes a contribution towards filling this gap in the literature.

Another contribution of this paper is that, different from other studies in the existing literature, it studies the interaction between increasing returns in the process of producing housing services, and land use restrictions that limit the output of housing services. There are at least two reasons for incorporating increasing returns in our analysis. First, at a general level, there is a growing recognition that increasing returns are theoretically important (Arrow, Ng, & Yang, 1998; Buchanan & Yoon, 1994; Helpman & Krugman 1985; Ng, 2009) and empirically significant (Antweiler & Trefler, 2002; Fingleton, 2003). Second, from the public policy perspective, there is an argument for subsidising industries with higher degrees of increasing returns because these industries tend to under-produce in a free market economy (Ng & Zhang, 2007). To the extent that there are notable increasing returns in the process of producing housing services (including the productions of inputs such as cement, steel etc.), housing production should arguably be subsidised. Rather than promoting housing production as called for by welfare maximisation considerations, land use controls restrict housing production. In addition to the well-understood distortion that a production restriction creates, land use controls also aggravate the inefficiency associated with under-production in the presence of increasing returns.
In section 2 below, we present a simple model with three sectors: agriculture, manufacturing and housing services. Assuming that increasing returns are present in the manufacturing and housing sector, we investigate the impact of land use controls (in the form of a fixed acreage reserved for agricultural use) on the housing market. Our analysis shows that if the land use controls are binding (i.e., the government fixed acreage for agricultural use is higher than the free market determined quantity), housing prices will be artificially pushed up. Moreover, with a higher degree of increasing returns in housing, the land use controls will create more price distortions which lead to larger welfare losses. In section 3, we calibrate our model to estimate the effects of land use controls on housing prices in China. Our results show that over the period 1998-2009, land use controls may have raised housing prices by 14-36%. In Section 4, we summarize our findings and discuss some limitations of our model.

2. Theoretical Model

2.1. Production technologies

Consider an economy with 3 final goods: the agricultural good \( Y_a \), the manufactured good \( Y_m \), and housing services \( Y_h \). The markets for the 3 final goods are assumed to be perfectly competitive, and the production functions for the final goods are:

\[
Y_a = A_a (T_a)^\alpha (L_a)^{1-\alpha} 
\]

\[
Y_m = A_m \left( \sum_{r=1}^{n} X_r^{\rho_{m}} \right)^{\beta} (L_m)^{1-\beta} 
\]

\[
Y_h = A_h \left( \sum_{s=1}^{q} X_s^{\rho_{h}} \right)^{\gamma} (T_h)^{\delta} (L_h)^{1-\gamma-\delta} 
\]
where $T_a, T_h$ are land inputs; $L_a, L_m, L_n$ are labor inputs and $x$ and $y$ are intermediate inputs. Equations (3) and (4) indicates that $n$ varieties of input $x$ are used in the production of the manufactured good; and $q$ varieties of input $y$ are used in the production of housing services. $n$ and $q$ are endogenously determined as will be shown later.

The markets for inputs $x$ and $y$ are assumed to be monopolistically competitive (Dixit & Stiglitz, 1977). Assuming symmetry, the production functions for the two types of inputs are:

$$
x = \frac{L_x - F_x}{c_x}; \quad y = \frac{L_y - F_y}{c_y}
$$

(4)

where $c_i, F_i (i = x, y)$ are the marginal cost and fixed cost of producing input $i (i = x, y)$. The production of inputs $x$ and $y$ exhibits increasing returns because of the fixed costs.

Given the technical features of the economy as described above, we study the equilibrium of the economy in two cases: (1) case 1 with no land use controls; and (2) case 2 with a minimum acreage of land reserved for the agricultural sector.

2.2. **Case 1: No land use controls**

In case 1, there are no land use controls and the equilibrium land allocation between agriculture and housing is determined by market forces. To characterize the equilibrium of the economy, we first specify the representative consumer’s and firms’ decision problems.

Assume that there are $L$ representative consumers in the economy. Each consumer earns a wage from one unit of labor endowment and gets a share of the rent for the land that all consumers jointly own. The consumers derive utility from the consumption of three final goods. Normalizing wage income to be 1, we have the decision problem for the representative consumer:
max \( U = (c_a)^\alpha (c_m)^\beta (c_h)^{\lambda - \eta} \) \hspace{1cm} (5)

subject to: \( p_a c_a + p_m c_m + p_h c_h = 1 + \frac{p_T T}{L} \)

where \( c_a, c_m, c_h \) are the quantities of agricultural good, manufactured good, and housing service, respectively; \( \lambda, \eta \) are preference parameters; \( p_T T / L \) is rent income.

Solving the consumer’s decision problem gives us the demand functions for the final goods:

\[
c_a = \frac{\lambda}{p_a} (1 + \frac{p_T T}{L}), \quad c_m = \frac{\eta}{p_m} (1 + \frac{p_T T}{L}), \quad c_h = \frac{1 - \lambda - \eta}{p_h} (1 + \frac{p_T T}{L}).
\] \hspace{1cm} (6)

There are three types of final-good-producing firms, their decision problems are as follows:

(1) Firms producing the agricultural good:

\[
\max p_a A_a (T_a)^\alpha (L_a)^{1-\alpha} - p_T T_a - L_a
\] \hspace{1cm} (7)

(2) Firms producing the manufactured good:

\[
\max p_m A_m (\sum_{r=1}^{n} x_r^m)^{\beta} (L_m)^{1-\beta} - \sum_{r=1}^{n} p_r x_r - L_m
\] \hspace{1cm} (8)

(3) Firms supplying housing service:

\[
\max p_h A_h (\sum_{s=1}^{q} y_s^h)^{\delta} (L_h)^{1-\delta} - \sum_{s=1}^{q} p_s y_s - p_T T_h - L_h
\] \hspace{1cm} (9)

Solving the above decision problems, we obtain

(1) The derived demand for land and labor used in agricultural production of unit output:

\[
T_a = \frac{\alpha p_a}{p_T}, \quad L_a = (1-\alpha) p_a.
\] \hspace{1cm} (10)
(2) The derived demand for each of the \( n \) varieties of input \( x \) and labor used in manufacturing production of unit output:

\[
x_r = \frac{\beta p_m}{p_r^{1-\rho_n} \left( \sum_{i=1}^{n} p_i^{\rho_n-1} \right)}, \quad L_m = (1-\beta)p_m. \tag{11}
\]

(3) The derived demand for each variety of input \( y \), land and labor used in supplying housing services of unit output:

\[
y_s = \frac{\gamma p_h}{p_s^{1-\rho_h} \left( \sum_{j=1}^{q} p_j^{\rho_h-1} \right)}, \quad T_h = \frac{\delta p_h}{p_T}, \quad L_h = (1-\gamma-\delta)p_h. \tag{12}
\]

Following Yang and Heijdra (1993), we derive the price elasticity of demand for each of the \( n \) varieties of inputs \( x \), and that for each of the \( q \) varieties of input \( y \):

\[
\frac{\partial \ln x_r}{\partial \ln p_r} = \frac{\rho_m - n}{n(1-\rho_m)}, \quad \frac{\partial \ln y_s}{\partial \ln p_s} = \frac{\rho_h - q}{q(1-\rho_h)} \tag{13}
\]

There are two types of input producers with the following decision problems:

(1) Firms producing input \( x \):

\[
\text{max } p_r(x_r)x_r - (c_x x_r + F_x)
\]  \( \tag{14} \)

(2) Firms producing input \( y \):

\[
\text{max } p_y(y)y - (c_y y + F_y)
\]  \( \tag{15} \)

With the knowledge of price elasticities of demand (equations (12)), it is straightforward to solve the above decision problems and obtain the prices for input \( x \) and \( y \):
Given our assumption of monopolistic competition in the input markets, the firms earn zero profits in equilibrium, which imply:

\[
p_r x_r = c_x x_r + F_x, \quad p_s y_s = c_y y_s + F_y
\]

Also, the following market clearing conditions are satisfied in equilibrium:

1. Market for the agricultural good: \( Lc_a = Y_a \),
2. Market for the manufactured good: \( Lc_m = Y_m \),
3. Market for housing services: \( Lc_h = Y_h \),
4. Market for land: \( T_a + T_h = T \),
5. Market for labor: \( L_a + L_m + L_h + nL_n + qL_y = L \).

The equilibrium of the economy under case 1 can be obtained by solving the system of equations consisting of (1) the solutions to consumers’ utility maximization problem (equations (6)); (2) the solutions to firms’ profit maximization problems (equations (10)-(12), (16)); (3) zero profit conditions (equations (17)); and (4) market clearing conditions (equations (18)-(22)). The equilibrium solutions are presented in Table 2.

2.3. Case 2: Land use controls in the form of minimum acreage reserved for agriculture

In case 2, the government regulates land use by reserving a minimum acreage of land for agriculture. This land use constraint, if it is binding (that is, if the minimum acreage is higher than the market determined land allocation to agriculture), will alter the decision problems of consumers and producers.
First, the land use constraint will divide the land market into two segments, resulting in two different land prices, which also affect the rent income received by consumers. Thus the representative consumer’s decision problem becomes:

\[
\max U = (c_a)^\lambda (c_m)^\eta (c_h)^{1-\lambda-\eta} \\
\text{subject to: } p_a c_a + p_m c_m + p_h c_h = 1 + \frac{p_T^a \bar{T} + p_T^h (T - \bar{T})}{L},
\]

where $\bar{T}$ is the quantity of land reserved for agriculture; $[p_T^a \bar{T} + p_T^h (T - \bar{T})]/L$ is a representative consumer’s share of rent from land.

Solving the above decision problem, we have the demand for final goods:

\[
c_a = \frac{\lambda}{p_a} I, \quad c_m = \frac{\eta}{p_m} I, \quad c_h = \frac{1-\lambda-\eta}{p_h} I
\]

where $I \equiv 1 + \frac{p_T^a \bar{T} + p_T^h (T - \bar{T})}{L}$.

Second, the land use controls determine the allocation of land between the agricultural and housing services sectors, thereby directly affecting the prices and outputs of these two sectors, with ramifications for other sectors. In the presence of land use controls, the decision problem for the representative firm in the agricultural sector changes to:

\[
\max p_a A_a (T_a)^\alpha (L_a)^{1-\alpha} - p_T^a T_a - L_a
\]

subject to: $T_a \geq \bar{T}$

where $p_T^a$ is the price of land for agricultural use.

Correspondingly, the decision problem for the representative firm in the housing services sector becomes:
\[
\text{max } p_h A_n \left( \sum_{s=1}^{q} y_s^h \right) \frac{\gamma}{\alpha} (T_h)^{\delta} (L_h)^{1-\gamma-\delta} - \sum_{s=1}^{q} p_s y_s - p_T^h T_h - L_h 
\]

subject to: \( T_h \leq T - \bar{T} \)

where \( p_T^h \) is the price of land used in providing housing services.

Assuming the land controls are binding, we can solve the decision problems (25)-(26) and obtain the demand for land and labor in the agricultural sector, and the demand for land, labor, and the intermediate input \( y \) in the housing services sectors:

\[
T_a = \bar{T}, \quad L_a = \frac{1-\alpha}{\alpha} p_T^a \bar{T}, \quad (27)
\]

\[
T_h = T - \bar{T}, \quad L_h = \frac{(1-\gamma-\delta)}{\delta} p_T^h (T - \bar{T}), \quad y_s = \frac{\gamma \delta}{\delta} p_T^h (T - \bar{T}) \quad (28)
\]

Following a similar approach as in case 1, and noting that the decision problems of other firms remain unchanged, we can characterize the equilibrium of the economy in case 2. The equilibrium solutions are presented in Table 3.

2.4. The Effects of Land Use Controls

We now study the effects of land controls by comparing case 1 and case 2. In our comparison, we assume that the land controls are binding, which means that in the absence of land controls (case 1), a smaller amount of land would have been allocated to agriculture, that is, the following condition holds:

\[
(T_a)_1 < (T_a)_2, \quad \text{or equivalently, } \alpha \lambda (T - \bar{T}) < \delta (1-\lambda - \eta) \bar{T} \quad (29)
\]

where subscript 1 and 2 denote case 1 and 2, respectively.
From the solutions in Tables 2 and 3, we can show that provided that condition (29) holds, we have

\[(p_T^2) < (p_T)_1, \quad (p_h^b) > (p_T)_1, \quad (p_a)_2 < (p_a)_1, \quad (p_h)_2 > (p_h)_1. \tag{30}\]

Thus we conclude:

**Proposition 1.** A binding land use constraint that reserves a minimum acreage of land for agricultural use would lower the price of agricultural land and the price of agricultural product; and raise the price of land for housing and the price of housing services.

From the equilibrium prices of housing services in case 1 and case 2 we derive that:

\[\frac{\partial p_h}{\partial F_y} > 0, \quad \frac{\partial p_h}{\partial F_y} > 0, \tag{31}\]

\[\frac{\partial p_h}{\partial F_y} > \left( \frac{\partial p_h}{\partial F_y} \right)_1 \quad \text{if} \quad \alpha \lambda (T - \bar{T}) < \delta (1 - \lambda - \eta) \bar{T}. \tag{32}\]

Inequalities (31) suggest that a higher fixed cost in the production of input \(y\) (used in the production of housing services) would result in a higher price of housing services with or without land use controls. Inequality (32) implies that in the presence of binding land use controls, an increase in the fixed cost in \(y\) production would lead to a larger price rise in housing services compared to the case without land use controls.

From the equilibrium quantities of final goods in case 2, we derive:

\[\left( \frac{\partial u^*}{\partial T} \right)_2 < 0, \quad \frac{\partial (\partial u^* / \partial T)}{\partial F_y} < 0 \tag{33}\]

Inequalities (33) suggest that an increase in land acreage reserved for agricultural use would lower consumer welfare, and that the reduction in consumer welfare is larger if the fixed cost in \(y\) production is larger.
We summarize the above discussion as follows:

**Proposition 2** If we use the fixed cost in the production of input to housing services as an indicator of increasing returns in housing production, the degree of increasing returns in housing production is positively related to housing prices. The positive impact of increasing returns on housing prices is greater in the presence of binding land use controls. Furthermore, binding land use controls would reduce consumer welfare, and the reduction of consumer welfare is greater if the degree of increasing returns in housing production is higher.

3. **Calibration**

As Proposition 1 above suggests, binding land use controls artificially raise the price of housing services. In this section, we calibrate our theoretical model in an attempt to estimate the extent to which housing prices in China may have been affected by the government’s policy of reserving 120 million hectares of land for agriculture use.

From the equilibrium solutions of housing prices, we obtain the ratio between housing price without land constraint and that with land constraint.

\[
\frac{(p_h)_2}{(p_h)_1} = \frac{(1-\lambda-\eta)^\delta(T-T')^{-\delta}}{\delta \{\alpha \lambda + \delta(1-\lambda-\eta)\}^{\delta-\delta}} = \left\{\frac{(1-\lambda-\eta)\delta T}{[\alpha \lambda + \delta(1-\lambda-\eta)](T-T')}\right\}^\delta (34)
\]

This price ratio informs us of the factors (parameters) that interact with the land constraint in raising housing prices. By calibrating this price ratio, that is, by assigning appropriate parameter values to quantify the price ratio, we get an estimate for the effect of land constraint on housing prices in China.

The parameters that determine the ratio between housing price without land constraint and that with land constraint include: \( \lambda \) (consumption share of agricultural goods), \( \eta \), and...
(consumption share of manufactured goods), $\alpha$ (income share of land rent in agricultural production), $\delta$ (income share of land in housing), $T$ (total quantity of land used in agriculture and housing), and $\bar{T}$ (total quantity of land reserved for agriculture). Based on data from Chinese Statistics Yearbook (1998-2009), we can obtain values for $\lambda$ and $\eta$ over the period 1998-2009. We also know that the total quantity of land reserved for agricultural use, $\bar{T}$, is 180 million hectares. However, we have to use our own estimates for $\alpha$, $\delta$ and $T$. The results of our calibration are presented in Table 4.

Our calibration suggests that over the period 1998-2009, reserving a minimum acreage of land for agricultural use might have raised the price of housing service by between 14-36%. Notably our estimation suggests that the price elevation induced by land use controls tended to increase over time as the income share of agricultural products ($\lambda$) fell, and the share of land rent in housing production ($\delta$) rose.

4. \textbf{Conclusion}

In this paper, we have presented a simple model to assess the likely impact of land use controls on the price of housing services in China. We have shown that the policy of reserving a minimum acreage for agriculture has the effect of raising housing prices, and lower consumer welfare. Moreover, to the extent that increasing returns exist in the process of providing housing services, the elevation in housing prices and the reduction in consumer welfare are exacerbated. Our estimation suggests that this policy may have led to an increase in housing prices by between 14-36% over the period 1998-2009. We note that this estimate is quite imprecise given that some of the parameters required in the estimation may not be reliable. However, our
estimate does seem to suggest that the potential price distortion and welfare harm of this type of land use controls can be considerable.

By itself, our paper does not imply that reserving a minimum land acreage for agricultural use is necessarily a bad policy as there are many other considerations, including environmental and strategic rationales for the policy. We merely point out that the policy has a perhaps unintended effect of raising housing prices. We contend that this effect is highly relevant in assessing the success or otherwise of the land use control policy and in evaluating the state of the Chinese housing market.
References


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Source: Chinese Statistics Yearbook
Table 2. Equilibrium solutions: case 1

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<th>Equation</th>
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<tbody>
<tr>
<td><strong>Number of varieties</strong></td>
<td>$n = \rho_m + \frac{(1 - \rho_m) \beta \eta L}{F_x[1 - \alpha \lambda - \delta (1 - \lambda - \eta)]}$,</td>
</tr>
<tr>
<td>of input $x$ and $y$</td>
<td>$q = \rho_h + \frac{(1 - \rho_h) \gamma (1 - \lambda - \eta)L}{F_y[1 - \alpha \lambda - \delta (1 - \lambda - \eta)]}$</td>
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<table>
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<tr>
<th><strong>Prices and quantities</strong></th>
<th>Equation</th>
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<tr>
<td>of inputs $x$, $y$</td>
<td>$p_r = \frac{c_x \beta \eta L}{\rho_m { \beta \eta L - F_x[1 - \alpha \lambda - \delta (1 - \lambda - \eta)] }}$</td>
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<td></td>
<td>$p_s = \frac{c_y \gamma (1 - \lambda - \eta)L}{F_s \rho_m { \beta \eta L - F_s[1 - \alpha \lambda - \delta (1 - \lambda - \eta)] }}$</td>
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<tr>
<td></td>
<td>$x_r = \frac{F_r \rho_m { \beta \eta L + \rho_m F_x[1 - \alpha \lambda - \delta (1 - \lambda - \eta)] }}{c_x { (1 - \rho_m) \beta \eta L }}$</td>
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<tr>
<td></td>
<td>$y_s = \frac{F_s \rho_m { \gamma (1 - \lambda - \eta) L - F_s[1 - \alpha \lambda - \delta (1 - \lambda - \eta)] }}{c_y { (1 - \rho_h) \gamma (1 - \lambda - \eta)L + \rho_h F_y[1 - \alpha \lambda - \delta (1 - \lambda - \eta)] }}$</td>
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<th><strong>Land price and land allocation</strong></th>
<th>Equation</th>
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<td></td>
<td>$p_T = \frac{[\alpha \lambda + \delta (1 - \lambda - \eta)] L T}{[1 - \alpha \lambda - \delta (1 - \lambda - \eta)] T}$</td>
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<td></td>
<td>$T_a = \frac{\alpha \lambda T}{[\alpha \lambda + \delta (1 - \lambda - \eta)]}$;</td>
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<td></td>
<td>$T_h = \frac{\delta (1 - \lambda - \eta) T}{[\alpha \lambda + \delta (1 - \lambda - \eta)]}$</td>
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<th>Equation</th>
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<td></td>
<td>$L_a = \frac{(1 - \alpha) \lambda L}{[1 - \alpha \lambda - \delta (1 - \lambda - \eta)]}$,</td>
</tr>
<tr>
<td></td>
<td>$L_m = \frac{(1 - \beta) \eta L}{[1 - \alpha \lambda - \delta (1 - \lambda - \eta)]}$,</td>
</tr>
<tr>
<td></td>
<td>$L_h = \frac{(1 - \gamma - \delta) (1 - \lambda - \eta)L}{[1 - \alpha \lambda - \delta (1 - \lambda - \eta)]}$,</td>
</tr>
<tr>
<td></td>
<td>$L_x = \frac{F_x \beta \eta L}{[(1 - \rho_m) \beta \eta L + \rho_m F_x[1 - \alpha \lambda - \delta (1 - \lambda - \eta)]]}$</td>
</tr>
<tr>
<td></td>
<td>$L_y = \frac{F_y \gamma (1 - \lambda - \eta)L}{[(1 - \rho_h) \gamma (1 - \lambda - \eta)L + \rho_h F_y[1 - \alpha \lambda - \delta (1 - \lambda - \eta)]]}$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Prices of final goods</strong></th>
<th>Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$p_{a} = A_{n}^{-1} [\alpha \lambda + \delta (1 - \lambda - \eta)]^{\alpha} + (1 - \alpha)^{\alpha - 1} L^{\alpha} T^{-\alpha}$</td>
</tr>
<tr>
<td></td>
<td>$p_{m} = A_{m}^{-1} [\rho_m F_x + (1 - \rho_m) \beta \eta L]^{\beta} \frac{\lambda}{\rho_m} + \frac{\beta}{\rho_m} \rho_m (\beta \eta L - F_x)_{-\beta}$</td>
</tr>
<tr>
<td></td>
<td>$[1 - \alpha \lambda - \delta (1 - \lambda - \eta)]^{-\beta} c_x { (1 - \beta)^{\beta - 1} \eta L^\beta }$</td>
</tr>
<tr>
<td></td>
<td>$p_{h} = A_{h}^{-1} F_s \frac{\lambda}{\rho_h} + \frac{\lambda}{\rho_h} c_x \delta (1 - \lambda - \eta)^{\gamma} [\alpha \lambda + \delta (1 - \lambda - \eta)]^{\alpha} + (1 - \alpha)^{\alpha - 1} L^{\alpha} T^{-\alpha}$</td>
</tr>
<tr>
<td></td>
<td>$(1 - \gamma - \delta)^{\gamma - \delta - 1} (1 - \rho_h) \gamma (1 - \lambda - \eta)L + \rho_h F_y[1 - \alpha \lambda - \delta (1 - \lambda - \eta)]^{\gamma} + (1 - \alpha) + (\gamma L - F_y[1 - \alpha \lambda - \delta (1 - \lambda - \eta)])^{\gamma - \delta}$</td>
</tr>
<tr>
<td></td>
<td>${ \gamma (1 - \lambda - \eta)L - F_y[1 - \alpha \lambda - \delta (1 - \lambda - \eta)] }^{\gamma - \delta}$</td>
</tr>
</tbody>
</table>
Table 3. Equilibrium solutions: case 2

<table>
<thead>
<tr>
<th>Number of varieties of input ( x ) and ( y )</th>
<th>( n = \rho_m + \frac{(1 - \rho_m)\beta \eta L}{F_x[1 - \alpha \lambda - \delta(1 - \lambda - \eta)]} ), ( q = \rho_h + \frac{(1 - \rho_h)\gamma(1 - \lambda - \eta)L}{F_y[1 - \alpha \lambda - \delta(1 - \lambda - \eta)]} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prices and quantities of inputs ( x, y )</td>
<td>( p_r = \frac{c_x \beta \eta L}{\rho_m {\beta \eta L - F_x[1 - \alpha \lambda - \delta(1 - \lambda - \eta)]}} ), ( p_s = \frac{c_y \gamma(1 - \lambda - \eta)L}{\rho_h {\gamma(1 - \lambda - \eta)L - F_y[1 - \alpha \lambda - \delta(1 - \lambda - \eta)]}} )</td>
</tr>
<tr>
<td></td>
<td>( x = \frac{F_x \rho_m {\beta \eta L - F_x[1 - \alpha \lambda - \delta(1 - \lambda - \eta)]}}{c_x {(1 - \rho_m)\beta \eta L + \rho_m F_x[1 - \alpha \lambda - \delta(1 - \lambda - \eta)]}} )</td>
</tr>
<tr>
<td></td>
<td>( y = \frac{F_y \rho_h \gamma(1 - \lambda - \eta)L - F_y[1 - \alpha \lambda - \delta(1 - \lambda - \eta)]}{c_y {(1 - \rho_h)\gamma(1 - \lambda - \eta)L + \rho_h F_y[1 - \alpha \lambda - \delta(1 - \lambda - \eta)]}} )</td>
</tr>
<tr>
<td>Land price and land allocation</td>
<td>( p_r^a = \frac{\alpha \lambda L}{[1 - \alpha \lambda - \delta(1 - \lambda - \eta)]T} ), ( p_r^b = \frac{\delta(1 - \lambda - \eta)L}{[1 - \alpha \lambda - \delta(1 - \lambda - \eta)](T - \bar{T})} )</td>
</tr>
<tr>
<td></td>
<td>( T_a = \bar{T}, \ T_h = T - \bar{T} )</td>
</tr>
<tr>
<td>Labor allocation</td>
<td>( L_a = \frac{(1 - \alpha)\lambda L}{[1 - \alpha \lambda - \delta(1 - \lambda - \eta)]}, \ L_m = \frac{(1 - \beta)\eta L}{[1 - \alpha \lambda - \delta(1 - \lambda - \eta)]} )</td>
</tr>
<tr>
<td></td>
<td>( L_h = \frac{(1 - \gamma - \delta)(1 - \lambda - \eta)L}{[1 - \alpha \lambda - \delta(1 - \lambda - \eta)]}, \ L_x = \frac{F_x \beta \eta L}{{(1 - \rho_m)\beta \eta L + \rho_m F_x[1 - \alpha \lambda - \delta(1 - \lambda - \eta)]}} )</td>
</tr>
<tr>
<td></td>
<td>( L_y = \frac{F_y \gamma(1 - \lambda - \eta)L}{{(1 - \rho_h)\gamma(1 - \lambda - \eta)L + \rho_h F_y[1 - \alpha \lambda - \delta(1 - \lambda - \eta)]}} )</td>
</tr>
<tr>
<td>Prices of final goods</td>
<td>( p_a = A_x^{-1} \lambda^\alpha (1 - \alpha)^{\alpha - 1}[1 - \alpha \lambda - \delta(1 - \lambda - \eta)]^{-\alpha} L^\alpha T^{-\alpha} )</td>
</tr>
<tr>
<td></td>
<td>( p_m = A_m^{-1}[\rho_m F_x + (1 - \rho_m)\beta \eta L]^\beta \frac{\beta}{\beta \eta L} F_x^{\beta - \beta} \rho_m^{-\beta} (\beta \eta L - F_x)^{-\beta}[1 - \alpha \lambda - \delta(1 - \lambda - \eta)]^{-\beta} c_x^{\beta}(1 - \beta)^{\beta - 1} \eta^\beta L^\beta )</td>
</tr>
<tr>
<td></td>
<td>( p_h = A_h^{-1} F_y^{\gamma - \gamma} \rho_h^{-\gamma} c_y^{\gamma}[1 - \alpha \lambda - \delta(1 - \lambda - \eta)]^{\gamma - \gamma} (1 - \gamma - \delta)^{\gamma + \gamma - 1}(1 - \lambda - \eta)^{\gamma + \gamma} )</td>
</tr>
<tr>
<td></td>
<td>( {F_y \rho_h[1 - \alpha \lambda - \delta(1 - \lambda - \eta)] + (1 - \rho_h)\gamma(1 - \lambda - \eta)L}^{\gamma - \gamma} )</td>
</tr>
<tr>
<td></td>
<td>( {\gamma(1 - \lambda - \eta)L - F_y[1 - \alpha \lambda - \delta(1 - \lambda - \eta)]}^{-\gamma}(T - \bar{T})^{-\gamma} L^{\gamma + \gamma} )</td>
</tr>
</tbody>
</table>
Table 4. Calibration Results

<table>
<thead>
<tr>
<th>Year</th>
<th>$\lambda$</th>
<th>$1 - \lambda - \eta$</th>
<th>$\eta$</th>
<th>$\alpha$</th>
<th>$\delta$</th>
<th>$T$ (million hectares)</th>
<th>$\overline{T}$ (million hectares)</th>
<th>$(p_h)_2 (p_h)_1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998</td>
<td>0.447</td>
<td>0.0943</td>
<td>0.4587</td>
<td>0.1</td>
<td>0.3</td>
<td>160</td>
<td>120</td>
<td>1.140547</td>
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<tr>
<td>1999</td>
<td>0.421</td>
<td>0.0984</td>
<td>0.4806</td>
<td>0.1</td>
<td>0.31</td>
<td>160</td>
<td>120</td>
<td>1.174504</td>
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<tr>
<td>2000</td>
<td>0.394</td>
<td>0.1001</td>
<td>0.5059</td>
<td>0.1</td>
<td>0.32</td>
<td>160</td>
<td>120</td>
<td>1.205673</td>
</tr>
<tr>
<td>2001</td>
<td>0.382</td>
<td>0.1032</td>
<td>0.5148</td>
<td>0.1</td>
<td>0.33</td>
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<td>120</td>
<td>1.232751</td>
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<tr>
<td>2002</td>
<td>0.377</td>
<td>0.0959</td>
<td>0.5271</td>
<td>0.1</td>
<td>0.34</td>
<td>160</td>
<td>120</td>
<td>1.233784</td>
</tr>
<tr>
<td>2003</td>
<td>0.371</td>
<td>0.1074</td>
<td>0.5216</td>
<td>0.1</td>
<td>0.35</td>
<td>160</td>
<td>120</td>
<td>1.277518</td>
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<tr>
<td>2004</td>
<td>0.377</td>
<td>0.1021</td>
<td>0.5209</td>
<td>0.1</td>
<td>0.36</td>
<td>160</td>
<td>120</td>
<td>1.277619</td>
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<tr>
<td>2005</td>
<td>0.367</td>
<td>0.1018</td>
<td>0.5312</td>
<td>0.1</td>
<td>0.37</td>
<td>160</td>
<td>120</td>
<td>1.298561</td>
</tr>
<tr>
<td>2006</td>
<td>0.358</td>
<td>0.1040</td>
<td>0.5380</td>
<td>0.1</td>
<td>0.38</td>
<td>160</td>
<td>120</td>
<td>1.325335</td>
</tr>
<tr>
<td>2007</td>
<td>0.363</td>
<td>0.0983</td>
<td>0.5387</td>
<td>0.1</td>
<td>0.39</td>
<td>160</td>
<td>120</td>
<td>1.324106</td>
</tr>
<tr>
<td>2008</td>
<td>0.379</td>
<td>0.1019</td>
<td>0.5191</td>
<td>0.1</td>
<td>0.4</td>
<td>160</td>
<td>120</td>
<td>1.33844</td>
</tr>
<tr>
<td>2009</td>
<td>0.365</td>
<td>0.1002</td>
<td>0.5348</td>
<td>0.1</td>
<td>0.41</td>
<td>160</td>
<td>120</td>
<td>1.360316</td>
</tr>
</tbody>
</table>

Sources: $\lambda, \eta$: Chinese Statistics Yearbooks (1998-2009)  
$\alpha, \delta, T$: Authors’ own estimates
Figure 1. GDP Growth vs. Growth of Housing Prices