



Local officials as land developers: Urban spatial expansion in China

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ABSTRACT

We investigate conceptually and empirically the role of economic incentives in the primary land allocation in China in the recent years. A theoretical analysis demonstrates how recent fiscal and governance reforms give rise to land conversion decisions and long run urban spatial sizes that respond to economic incentives even though the allocation of land between urban and rural uses is determined administratively. An econometric investigation of China's coastal provinces finds that changes in urban area are increasing in the value of urban land and budgetary government revenues and decreasing in the value of agricultural land, results consistent with the theoretical analysis.

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1. Introduction

China's remarkable economic growth has been accompanied by an almost equally rapid growth in urbanization—spatially as well as economically and in terms of population. Urban expansion is, of course, a normal concomitant of economic growth, and empirical studies of China find a strong association between economic growth and urban spatial expansion (Seto and Kaufman, 2003; Ho and Lin, 2004; Deng et al., 2008). Nevertheless, the rapid rate of urban land expansion has been a cause of concern due to the social disruptions and rural unrest it has engendered, fears about China's ability to ensure food security, and an apparent erosion of the central government's ability to maintain control over development (Cao, 2004; Lin and Ho, 2005; Deng et al., 2006; Lichtenberg and Ding, 2008).

Like China's economic growth both nationwide and in urban areas, the spatial expansion of Chinese cities appears to have been unleashed by economic liberalization reforms that gave freer rein to market forces, most notably the creation of a secondary market for private sector long-term leasing of the rights to use existing urban land (Ding, 2004; Lin and Ho, 2005; Deng, 2005; Zhu, 2005). Case studies have documented the ways in which cities such as Shanghai, Beijing, Guangzhou, Guangdong, and others expanded

spatially in the aftermath of these reforms (Wu and Yeh, 1997; Wu, 1998; Gaubatz, 1999; Yeh and Li, 1999; Fu et al., 1999; Lin, 2001; Cartier, 2001; Deng, 2004; Tan et al., 2005).

There are, however, limits to the degree to which these reforms have liberalized land use. Land in China remains state owned. The primary allocation of land is controlled by government entities operating within a centralized bureaucratic structure. Urban land is under the control of municipal officials. Rural land is controlled by village officials. The central and provincial governments retain the right to requisition land for infrastructure, public services, and other designated uses as well as exercising oversight over the activities of local urban and village officials. Central and provincial government oversight was strengthened in 1998 by revisions to the land administration law establishing stringent administrative restrictions on farmland conversion (Lin and Ho, 2005; Lichtenberg and Ding, 2008).

But economic incentives may continue to undermine centralized administrative control over primary land allocation despite these administrative restrictions, due largely to reforms in governance implemented during the 1990s. These reforms decentralized authority over economic growth management and devolved greater responsibility for raising government revenue from the central government to local authorities. The new responsibilities imposed on local officials by these governance reforms enhanced the degree to which these officials were subject to economic incentives, raising the possibility that primary land allocation—and thus urban spatial expansion—might be increasingly driven by market forces.

This paper investigates conceptually and empirically the extent to which economic incentives have been shaping urban spatial expansion in China. We begin with a brief description of the institutions governing primary land allocation in China and of the governance reforms that transformed the decision framework in which municipal officials operate. We then present a theoretical model of municipal officials' decisions regarding primary land allocation deci-

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sions with an emphasis on urban spatial expansion, that is, conversion of rural land to urban uses. The model shows how municipal officials' responsibilities for promoting economic growth and managing public finances give rise to incentives for converting rural land to urban uses similar to those generated by liberalized land markets. We then conduct an econometric investigation of factors influencing urban spatial expansion in China using data on land use, economic activity and government finance in China's coastal provinces, the region of China that has experienced the most rapid economic growth in the recent years. Consistent with the results of the theoretical model, we find that changes in urban area are increasing in the value of urban land and in budgetary government revenues and decreasing in the value of agricultural land.

2. Land allocation in China

All land in China is formally under public ownership but is increasingly subject to private control. The key institutional change permitting expanded private land utilization was the introduction of long-term leases for land use rights, first introduced in Shenzhen in 1987, formally approved there on an experimental basis in 1988, and subsequently expanded to the rest of the country in 1992 (Deng, 2005; Zhu, 2005). Urban land belongs to the state and is administered by local officials who lease out use rights to private entities under long-term (40–70 years) contracts. Transactions in the market for use rights involve payment of an up-front conveyance fee, which was historically set mainly by negotiation but is increasingly set by auction or tenders subject to competitive bidding (Ding, 2007).

Rural land is administered by village collectives, which have authority to allocate land for rural housing, village public works, and village enterprises in addition to agriculture. Any other use of rural land requires a change in status from rural to urban land, accomplished by a process reminiscent of the exercise of eminent domain. The process begins when local urban officials requisition rural land for conversion to urban uses. (Provincial and central government authorities may also requisition land for large-scale infrastructure development and other public sector uses.) Compensation is required. Since there are no markets for rural land, compensation is determined by an administrative formula based largely on agricultural productivity and including payments for land, crops currently under cultivation, attachments to land, and land improvements. Because social services are tied to residency status (*hukou*), the compensation package also includes subsidies for resettlement. Even so, compensation is typically substantially less than the conveyance fees prevailing in rapidly growing parts of China (Ding, 2007).

Requisitions of farmland are subject to oversight from higher authorities, at least in principle. In 1998, the central government strengthened that oversight by imposing a set of strict administrative controls, including designation of land as basic farmland whose conversion to urban uses is prohibited and the so-called dynamic balance policy requiring that conversion of farmland be balanced by reclamation, land consolidation or other means (Lichtenberg and Ding, 2008). Implementation of these controls at the provincial level followed gradually. These measures appear to have had relatively little effect on the rate of urban spatial expansion in China: according to official land use statistics from China's Ministry of Land and Resources, between 1999 and 2004 land in cities grew at an average of around 262,000 hectares per year compared to an average of 213,000 hectares per year between 1996 and 1999.

3. Decentralization and land development pressure

As part of its process of economic liberalization in the pursuit of higher economic growth rates, China implemented a number of

reforms that decentralized its systems of governance and public finance. Together, these reforms appear to have pushed local officials to take on the role of land developers, using their control over primary land allocation to promote economic growth and meet the financial obligations of municipal governments.

Financial reforms began with the substitution of taxation for remittance of enterprise profits in the mid-1980s. During the same period, the central government relaxed its control over investment decisions and growth management, transferring these responsibilities to officials at the local level. The result of these reforms was what some have termed the "local developmental state", referring to local governments that actively promote both public and private investments aimed at achieving greater economic growth (Zhu, 2005). Promoting economic growth has been one of the highest priorities of the Chinese government at all levels. China counts on a rising standard of living to ensure social stability and strengthen the nation. Industrial development is widely seen as the key to economic growth and a rising standard of living for municipalities as well as for the nation as a whole. Devolving responsibility for investment decisions and growth management to local officials can be a means of increasing economic growth because local officials can be more informed about local conditions and are likely to be more responsive to local demand for infrastructure, services, and other forms of support for local business development that may not be apparent to central authorities (Zhang and Zhou, 1998; Lin and Liu, 2001; Jin et al., 2005). This form of decentralization can enhance performance incentives by creating yardstick competition for promotion opportunities and by transforming soft budget constraints into hard ones (Lin and Liu, 2001; Li and Zhou, 2005). Empirical studies indicate that performance in fostering economic growth is a key to advancement for local officials as they compete for advancement with officials from other localities (Head and Ries, 1996; Li and Zhou, 2005). Local government investment activity also gives officials access to sources of wealth and power within their local communities (Hsing, 2006; Deng, 2005).

These fiscal and governance reforms were followed in the mid-1990s by a new set of fiscal measures that included a reallocation of tax revenues in favor of the central government, which had run persistent deficits, at the expense of local governments, which had run persistent surpluses (Wong and Bhattasali, 2003; Zhang and Martinez-Vazquez, 2003; Zhang and Liu, 2003). These reforms did not, however, change local governments' expenditure obligations nor did they lessen the pressure on local governments to invest in infrastructure and other measures to promote economic growth.

Land development offers the promise of promoting economic growth and relieving financial pressure at the same time. The formula that sets compensation for requisitioned farmland fixes compensation at a level typically far below the conveyance fees local governments collect as up-front payments for long-term leases in the secondary land market, at least in areas experiencing significant economic growth. The fragmentary anecdotal evidence available indicates that conveyance fees often amount to 10–20 times the level of compensation for requisitioned farmland (Investigating Group of Land Acquisition Reform of Ministry of Land and Resources 2003).¹ Local governments retain all profits from land transactions. The evidence available indicates that many localities rely heavily on land transactions to finance both ongoing obligations

¹ Redevelopment of existing urban land does not typically offer the same opportunities for rent capture. State-owned enterprises rather than local governments stand to profit from conversion of the significant share of existing urban land under their control (Hsing, 2006). Redevelopment of existing urban land under local government control tends to be quite expensive due to high costs of resettling and compensating existing tenants (Fu et al., 1999; Zhou and Ma, 2000; Lin, 2007).

for public service provision and new investments in infrastructure needed to promote further economic growth (Wu and Yeh, 1997; Peterson, 2006; Lin, 2007; Ding, 2007). Survey data show that conveyance fees accounted for an estimated 27% of local government revenue nationally (Ping, 2006). The share of government revenue derived from land transactions is even greater in some localities (Yang and Wu, 1996; Liu, 2005).

4. A model of local officials' land allocation decisions under decentralization and fiscal reform

The following conceptual model formalizes the incentive structures placing local officials in China in the position of land developers. We use a dynamic model of aggregate land use based on the work of Hartwick et al. (2001); the model is essentially the same as that used by Turnbull (2007) to study transition dynamics under urban growth boundaries, modified to fit China's institutional structure. For simplicity, we consider a region with two sectors—one urban, the other agricultural. Extension to the case of multiple industries in the urban sector is straightforward but complicates the analysis without adding much insight.

The total land area of the region is divided between agricultural and urban uses. For simplicity we normalize the total land area of the region to 1. Let $L(t)$ denote the share of land in the region in urban uses in period t and $A(t) = 1 - L(t)$ the share devoted to agriculture during that period. The change in the stock of urban land at any time t is

$$\dot{L}(t) = X(t), \quad (1)$$

where $X(t)$ is the amount of land converted from agricultural to urban use during period t . A positive value of $X(t)$ denotes conversion from agriculture to urban uses; a negative value of $X(t)$, a reversion from urban to agricultural uses.

Local urban government officials choose the amount of land converted from agricultural to urban use by requisitioning agricultural land. Let $C(1 - L(t))$ denote unit compensation for agricultural land. The fact that compensation is determined by agricultural productivity suggests that compensation should be a function of the stock of agricultural land. Diminishing marginal productivity suggests that unit compensation is decreasing in the stock of agricultural land at a decreasing rate, i.e., $C''((1 - L(t)) < 0, C'(1 - L(t)) \geq 0$. The local government receives conveyance fees $V(X(t))$ from leasing land use rights to requisitioned farmland. We assume that $V(X(t))$ is increasing and concave in the amount of land leased $X(t)$.

Economic activity in the urban area, measured by GDP, is an increasing, concave function of the stock of urban land, $R(L(t))$. Local government revenue is derived partly from the local government's share of value-added taxes derived from urban sector GDP, $\tau R(L(t))$, and partly from profit from land conversion, $V(X(t)) - C(1 - L(t))X(t)$. Let $\gamma \geq 1$ be the weight placed on performance in fiscal management, which we assume to be increasing in the degree of financial pressure experienced by local officials in meeting obligations for spending on social services and investing in local infrastructure. Let δ be the discount rate, that is, local officials' rate of time preference for obtaining results from their activities.

Our assumptions imply that $(1 + \gamma\tau)R(L(t)) + \gamma[V(X(t)) - C(1 - L(t))X(t)]$ is concave in $(L(t), X(t))$. We also impose the assumptions $\frac{1+\gamma\tau}{\gamma\delta}R'(0) - C(1) + V'(0) > 0$ and $\frac{1+\gamma\tau}{\gamma\delta}R'(1) - C(0) + V'(0) < 0$ to ensure that some land in the region remains in both agricultural and urban uses in the long run.

The objective of local officials is to maximize their ongoing rewards from the central government. They thus choose land conversion $X(t)$ at each point in time to maximize the present value of these rewards

$$\int_0^\infty \{R(L(t)) + \gamma(\tau R(L(t)) + V(X(t)) - C(1 - L(t))X(t))\} e^{-\delta t} dt \quad (2)$$

subject to the state Eq. (1) and an initial condition on the amount of land in urban uses, $L(0) = L_0$. The initial stock of urban land is likely less than the long run equilibrium amount, as is characteristic of developing countries in general and China in particular, which is widely regarded as under-urbanized (Au and Henderson, 2006).

Letting $\lambda(t)$ to denote the shadow price of urban land at time t and dropping the time argument to simplify the exposition, the necessary conditions for a maximum include:

$$\gamma[V'(X) - C(1 - L)] + \lambda = 0 \quad (3)$$

$$\delta\lambda - (1 + \gamma\tau)R'(L) - \gamma C'(1 - L)X = \dot{\lambda} \quad (4)$$

plus the state Eq. (1) and the initial condition on urban land. Eq. (3) indicates that local officials' land conversion decisions are motivated by both short run profit from land transactions $V'(X) - C(1 - L)$ and the long run value of adding to the stock of urban land, represented by its shadow price $\lambda(t)$.

Further insight into the nature of the long run value of the urban land stock to Chinese local government officials can be obtained from an explicit representation of the shadow price of urban land, derived by integrating the costate Eq. (4) to get:

$$\lambda(t) = \int_t^\infty \{R'(L) + \gamma[\tau R'(L) + C'(1 - L)X]\} e^{-\delta(s-t)} ds. \quad (5)$$

The shadow price of the stock of urban land at any point in time has two components: (a) its contribution to future economic growth $R'(L)$ and (b) its net contribution to alleviating future fiscal pressure $\gamma[\tau R'(L) + C'(1 - L)X]$, which is positive as long as tax revenues from increased economic activity in the urban area $\tau R'(L)$ exceed the increase in compensation for requisitioned agricultural land caused by the rising scarcity of agricultural land $C'(1 - L)X$.

Combining Eqs. (3) and (5) gives a single equation defining optimal land conversion conditional on the stock of urban land at any point in time. Differentiating the resulting equation (see the Appendix for a formal derivation) gives the following predictions about conditions influencing the rate at which agricultural land is converted to urban uses, that is, the rate of urban spatial expansion:

Result 1. The rate of urban spatial expansion is higher in areas where land conversion is more profitable.

Result 2. The rate of urban spatial expansion is lower in areas where agricultural productivity (and hence compensation for land conversion) is higher.

Result 3. The rate of urban spatial expansion is higher in areas with greater expected tax revenues.

In the section that follows, we examine empirically whether changes in urban area are consistent with these results.

In long run equilibrium, when both land conversion and the change in the shadow price of urban land equal zero, the shadow price of urban land is

$$\lambda^* = \frac{1 + \gamma\tau}{\delta} R'(L) \quad (6)$$

and thus the amount of land in urban use is defined by:

$$F(L) \equiv V'(0) + \frac{1 + \gamma\tau}{\gamma\delta} R'(L) - C(1 - L) = 0 \quad (7)$$

$F(L)$ is monotonically decreasing in L ($F'(L) = (1 + \gamma\tau) R''(L)/\gamma\delta + C'(1 - L) < 0$), so if $F(0) > 0$ and $F(1) < 0$, as assumed above, there exists a unique long run equilibrium stock of urban land L^* . In the Appendix, we show that this long run equilibrium is stable with

unique transition paths for the cases in which the region is under- and over-urbanized initially relative to the long run equilibrium.

The economic determinants of the long run equilibrium amount of urban land are similar to those characterizing long run equilibrium in markets with completely private land ownership. The long run equilibrium shadow price of urban land is the present value of rent generated by land at the margin, $R'(L^*)/\delta$, weighted by the degree of fiscal pressure and its contribution to tax revenues, $(1 + \gamma\tau)$. The long run equilibrium amount of urban land equates the shadow price of urban land, weighted by $1/\gamma$, with the unit cost of acquiring agricultural land, $C(1 - L^*)$, net of short-term profits from the first unit of land converted from agricultural to urban use, $V(0)$. In a competitive market with fully private land ownership, the long run equilibrium amount of urban land would equate the after-tax present value of rent generated by urban land at the margin, $(1 - \tau)R'(L)/\delta$, with the cost of acquiring agricultural land which, like compensation for requisitioned agricultural land, $C(1 - L^*)$, is a function of agricultural productivity. Thus, decentralization of governance and reforms of the fiscal system, taken together, should result in land allocations that are influenced by land values in a manner similar to those of competitive land market with fully private ownership, even when primary land allocation remains in the hands of government officials nominally subject to bureaucratic constraints on decision making. The principal difference lies in the role of taxes. Local officials value land for its capacity to generate tax revenues over the long run as well as for its ability to generate short run profits, so taxes enhance returns to land conversion. For private developers, in contrast, taxes reduce returns to land conversion rather than increasing them. Thus, raising tax rates has the opposite effect on land development in China than it has in competitive private land markets.

5. Urban spatial expansion in coastal China

Our empirical study examines the degree to which the allocation of land between urban and rural uses has been determined by economic influences in the years following implementation of these governance and fiscal reforms. We focus on three factors identified in the theoretical analysis: the value of urban land (a determinant of both the profitability of conversion and the shadow price of urban land), the value of agricultural land (the basis for compensation), and government revenue (a determinant of the shadow price of urban land).

5.1. Data

We investigate the role of economic incentives in urban spatial expansion in the region of China experiencing the most rapid economic growth in the recent years: the coastal provinces such as Liaoning, Hebei, Shandong, Jiangsu, Zhejiang, Fujian, and Guangdong, plus the provincial level cities such as Beijing, Tianjin, and Shanghai. We restrict our analysis to the time period beginning in 1996, the first year in which reliable land use data are available, and ending in 2004. We use a panel of time-series cross-section data obtained from two sources. Prefecture-level data on land area (measured in *mu*, equivalent to about 1/15 hectare) in a wide variety of uses, including land in cities and land planted to major crops ("cultivated land") and horticultural crops, come from records maintained by China's Ministry of Land and Resources, which collects that information from its local subordinates on an annual basis. Prefecture-level economic and demographic data for that same time period come from provincial statistical yearbooks for the years 1997–2005. These data include GDP (measured as value added) in total and by sector (primary, secondary, and tertiary), the value of agricultural output, and government budgetary revenue,

all measured in RMB 10,000 and converted to constant 2005 price levels using the fixed price consumer price index reported by China's National Bureau of Statistics (2006). The data set contains information on 99 prefectures. Descriptive statistics of the data used are given in Table 1.

Overall, the urbanized area of this region increased by 23,347 hectares between 1996 and 2004, an average annualized rate of 1.5 percent per year or 236 hectares per prefecture per year (Table 2). Year-to-year growth rates of urban area in the region as a whole ranged from 2.0 percent in 1999–2000 to 6.3 percent in 2003–2004 (Fig. 1). Cities in Zhejiang and Jiangsu, Fujian, and Shandong Provinces grew most rapidly; the provincial level cities such as Shanghai and Tianjin had the lowest average growth rates. Average year-to-year rates of urban expansion ranged from a low of 0.01 percent (Huizhou Prefecture in Guangdong Province) to a high of 20.48 percent (Zhenjiang Prefecture in Jiangsu Province). One prefecture (Shanwei Prefecture in Guangdong Province) had no land classified as urban throughout the entire period and thus experienced no growth. A few prefectures (Rizhao and Liaocheng Prefectures in Shandong Province and Zhuhai Prefecture in Guangdong Province) experienced shrinkage in urban area, which can occur because not all land converted from rural to urban status actually undergoes urban development: recent government investigations found that significant amount of land requisitioned and set aside in economic development zones remained vacant and ordered 13 million hectares nationwide (almost two-thirds of the land planned for these development zones) returned to agricultural use (Cao, 2004; Lin, 2007). Boundary adjustments can also cause shrinkage in urban area.

5.2. Specification and estimation of the econometric model

We examine whether changes in urban area are consistent with the predictions of our theoretical model using a model of the change in urban area during year t as a function of initial (period t) urban land value, agricultural land value, and government revenue:

$$\begin{aligned} X_{jt} &\equiv L_{j,t+1} - L_{jt} \\ &= b_1 \text{UrbanValue}_{jt} + b_2 \text{AgValue}_{jt} + b_3 \text{GovtRev}_{jt} + a_j + a_t + e_{jt}. \end{aligned} \quad (8)$$

Here a_j denotes unobserved factors influencing land conversion in prefecture j over the entire sample period, a_t denotes unobserved factors influencing all prefectures in year t , and e_{jt} is a white noise error. Results (1)–(3) imply that the change in urban area should be increasing in the value of urban land ($b_1 > 0$), decreasing in the value of agricultural land ($b_2 < 0$), and increasing in government revenue ($b_3 > 0$).

Table 1
Descriptive statistics of the data used in the analysis.

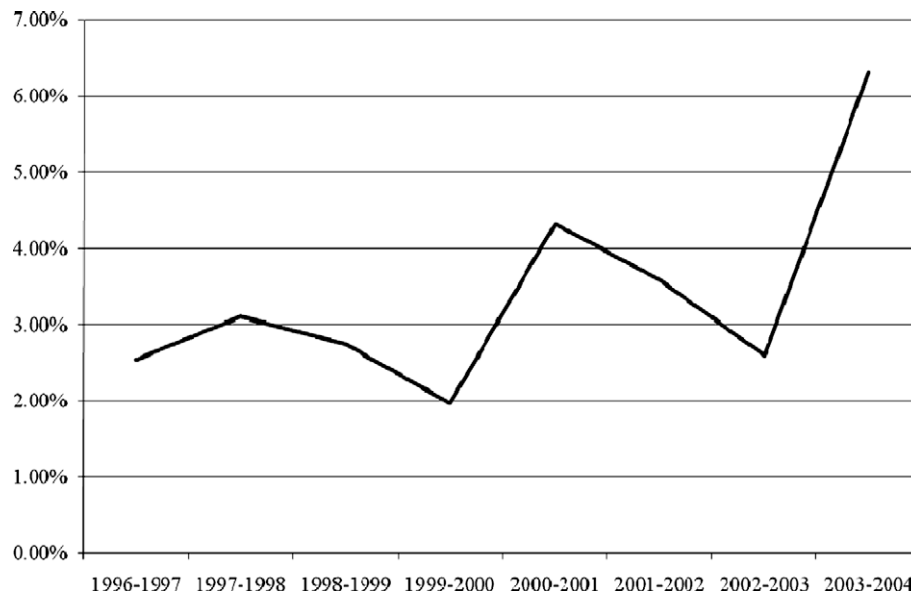
Variable	Mean	Standard deviation
Absolute change in urban area	3521.05	10376.45
Proportional change in urban area	0.040166	0.1000732
Urban land area	106000.8	91798.5
Agricultural land area	5424542	3550356.05
Urban GDP per unit land area	58.72914	42.3485429
Agricultural GDP per unit land area	0.172418	0.1086519
Agricultural output value per unit land area	0.300136	0.2055954
Government budgetary revenue per unit land area	3.269349	2.8280676
Number of observations	791	

Urban GDP, agricultural GDP, agricultural output value, and government budgetary revenue all in real year 2005 10,000 RMB per *mu*.

Table 2

Urban area (hectares) in coastal China by province, 1996–2004.

Province	1996	1997	1998	1999	2000	2001	2002	2003	2004	Annualized growth rate (%)
Beijing	23,209	23,251	23,371	23,425	23,858	27,549	27,408	28,196	29,713	3.1
Fujian	24,231	24,772	26,131	28,632	29,240	30,167	31,267	32,156	34,890	4.7
Guangdong	107,171	110,788	112,980	114,525	118,611	123,092	126,252	127,382	130,047	2.4
Hebei	74,630	77,874	78,859	79,981	80,722	83,978	84,813	84,738	84,893	1.6
Jiangsu	61,672	62,997	65,310	66,555	66,891	73,144	82,588	83,857	91,058	5.0
Liaoning	119,145	120,775	126,708	131,841	132,592	133,019	134,257	135,167	140,105	2.0
Shandong	119,296	121,578	126,368	130,780	133,671	138,858	141,980	150,334	171,107	4.6
Shanghai	27,881	27,881	28,818	28,821	28,827	28,827	28,827	28,827	28,827	0.4
Tianjin	20,251	20,404	20,404	20,404	20,442	20,612	20,693	20,924	21,543	0.8
Zhejiang	32,527	35,234	36,095	37,792	40,970	45,859	52,309	57,827	64,605	9.0
Total	610,012	625,554	645,045	662,756	675,825	705,103	730,392	749,410	796,787	3.4

**Fig. 1.** Year-to-year growth rates of urban area in China's coastal provinces, 1996–2004.

We modify the estimating Eq. (8) to allow for possible nonlinearities in two ways: (i) by adding quadratic terms:

$$\begin{aligned}
 X_{jt} &\equiv L_{j,t+1} - L_{jt} \\
 &= b_1 \text{UrbanValue}_{jt} + b_2 \text{AgValue}_{jt} + b_3 \text{GovtRev}_{jt} \\
 &\quad + b_4 \text{UrbanValue}_{jt}^2 + b_5 \text{AgValue}_{jt}^2 + b_6 \text{GovtRev}_{jt}^2 + a_j + a_t + e_{jt}
 \end{aligned} \quad (9)$$

and (ii) by regressing the percentage change in urban area on the logs of urban land value, agricultural land value, and government revenue:

$$\begin{aligned}
 \frac{X_{jt}}{L_{jt}} &= b_1 \log(\text{UrbanValue}_{jt}) + b_2 \log(\text{AgValue}_{jt}) + b_3 \log(\text{GovtRev}_{jt}) \\
 &\quad + a_j + a_t + e_{jt}.
 \end{aligned} \quad (10)$$

(We use the percentage change in urban land area rather than the log of urban area to accommodate prefectures with zero or negative growth in urban area.) Our theoretical analysis leads us to expect the coefficients b_1 , b_2 , and b_3 to have the same signs as noted above. Decreasing marginal effects of land values and government revenues implies b_1 , b_2 , $b_3 < 1$ in absolute value in the semilog model (10) and b_4 , $b_6 < 0$, $b_5 > 0$ in the quadratic model (9).

Ideally, our study would utilize data on compensation for agricultural land requisitioned for conversion to urban use and on conveyance fees paid for land use rights leases for each parcel of land. While there are some published aggregate data on land transac-

tions at the provincial level for some years, there are at present no systematic, reliable data on land transactions at more disaggregated levels over time. Even the most comprehensive published study we encountered, that of Ping (2006), which reported results of a survey of 8 provinces, 8 counties, and 3 cities, was forced to estimate land prices from more aggregated data using assumptions about leasing rates and utilization of land for public purposes.

Since data on marginal land values are lacking, we use measures of average values in their place. We use GDP in manufacturing and services per unit of urban land area in prefecture j and year t , $\text{UrbanValue}_{jt} = \text{GDP23}_{jt}/L_{jt}$, as a measure of the value of urban land and thus also the profitability of converting land from rural to urban status. Severe restrictions on industrial and commercial development in rural areas suggest that the overwhelming majority of secondary and tertiary GDP is generated in cities. We use two alternative measures of the value of agricultural land: the value of agricultural output per unit of agricultural land, $\text{AgValue}_{jt} = \text{O-VAG}_{jt}/A_{jt}$, and primary GDP per unit of agricultural land, $\text{AgValue}_{jt} = \text{GDP1}_{jt}/A_{jt}$, where A_{jt} denotes cropland, that is, the sum of cultivated and horticultural land. The value of agricultural output is the basis for determining compensation for land conversion, as noted above, and should thus constitute a more accurate measure of the economic disincentive for land conversion. But our data are missing observations for agricultural output value (see below), so we include primary GDP per unit of agricultural land—which includes forestry and fisheries as well as agriculture and thus over-

states the value added in agriculture but may understate the gross value of agricultural output—as a robustness check. We use budgetary government revenue per unit of land, $\text{GovtRev}_{jt} = \text{GR}_{jt}/L_{jt}$, as a measure of current (and thus expected) revenues from taxes and other normal sources of government income from urban land. These revenues are derived mainly from the urban sector.

Missing values for these variables lowered the usable sample to 791 observations over the 8-year period 1997–2004. As noted above, Shanwei Prefecture in Guangdong Province had no land classified as urban ($L_{jt} = 0$) during the entire sample period. We exclude it from the analysis because urban land value and government revenue per unit of land area are undefined for them. Shandong Province did not report the value of agricultural output for the years 1997–2000.

Hausman tests indicate rejecting the hypothesis of no correlation between prefecture- and year-specific unobservables a_j and a_t and the independent variables at a 5 percent significance level or better in all specifications of Eqs. (8)–(10). We thus estimate all specifications of these equations using prefecture- and year-specific fixed effects. The estimated coefficients of these models and their associated standard errors are given in Table 3.

5.3. Results

All of the estimated coefficients have signs consistent with the theoretical analysis. Changes in urban area are increasing in the value of urban land and in government revenues per unit of land and decreasing in the value of agricultural land. The estimated coefficients also provide evidence of decreasing marginal effects of both urban land value and government revenue per unit of land: the coefficients of the logs of urban land value and government revenue per unit of land are significantly different from zero and significantly less than one while the quadratic model features linear terms that are positive and significantly different from zero and quadratic terms that are negative and significantly different from zero.

The evidence regarding the effects of agricultural land value is somewhat weaker. While the coefficients of agricultural land value have the expected signs and are consistent with decreasing marginal effects, these coefficients are significantly different from zero only in (i) the linear specification when agricultural land value is estimated using primary sector GDP (and here only at a 10 percent significance level) and (ii) the semilog specification when agricultural land value is estimated using the value of agricultural output.

The linear and quadratic coefficients of agricultural land value are not jointly significantly different from zero in either quadratic specification.

The magnitudes of the effects of urban and agricultural land values and government revenues on the rate of urban land conversion are best gauged by the coefficients of the semilog model. These coefficients indicate that a one percent increase in urban land value is associated with a 0.12–0.13 percentage point increase in urban area; that a one percent increase in government revenue is associated with a 0.15–0.16 percentage point increase in urban area; and that a one percentage point increase in agricultural land value is associated with a 0.07–0.12 percentage point decrease in urban area. The magnitudes of the effects of urban land value and government revenues do not differ between the two specifications of agricultural land value. The magnitudes of the effects of agricultural land value are quite close in the two specifications as well. Overall, it appears that the magnitudes of the effects of these variables are robust at least to small changes in model specification.

These estimated coefficients suggest that the economic incentives investigated here can account for the bulk of urban spatial expansion in China's coastal provinces during the 1996–2004 period. Our data indicate that the total urbanized area of this region increased from 610,012 to 796,787 hectares, or 30.6 percent, during this period. The average value of urban land in the region increased in real terms from \$566,336 per hectare to \$1,041,579, or 86.1 percent; multiplying by an elasticity of 0.128 gives urban spatial growth of 10.7 percent due to the increased value of urban land. Average government revenue increased in real terms from \$26,743 per hectare to \$59,443 per hectare, or 122.3 percent; multiplying by an elasticity of 0.160 gives urban spatial growth of 20.0 percent due to expected enhancements to municipal finance. The average value of agricultural output increased from \$3290 per hectare to \$4812 per hectare, or 46.2 percent; multiplying by an elasticity of –0.120 gives a reduction in urban spatial area of 5.5 percent. Together, changes in these economic factors imply urban spatial growth of 24.8 percent, more than four-fifths of the total growth observed over this period in the region as a whole. (A similar calculation using the parameters of the semilog model estimated with GDP-based agricultural land value gives a predicted increase in urban land of 26.8 percent, accounting for seven-eighths of the growth observed.)

The magnitudes of these coefficients relative to each other are also of interest. Changes in government revenue have a greater proportional effect than changes in urban land value. Our review

Table 3
Estimated parameters of panel data models of urban spatial growth.

	Agricultural land value calculated using value of agricultural output		Agricultural land value calculated using primary GDP	
	Dependent variable = absolute change in urban land area			
Real urban land value	45.85007 (41.6723)	223.7759*** (83.1661)	53.70349 (40.6312)	217.8219*** (78.8009)
Real urban land value squared		−0.74859*** (0.2704)		−0.7222*** (0.2594)
Real agricultural land value	−9657.65 (9569.5)	−23371.2 (21245.2)	−25498.6 (15678)	−38532 (37172.5)
Real agricultural land value squared		3971.009 (10503.3)		10546.31 (43226.4)
Real government revenue per <i>mu</i>	1351.909*** (403)	3841.399*** (903.6)	1221.291*** (395.9)	3602.514*** (892.6)
Real government revenue per <i>mu</i> Squared		−112.95*** (40.4391)		−107.27*** (40.0883)
<i>N</i>	723	723	791	791
<i>R</i> ²	0.3113	0.3351	0.3040	0.3261
	Dependent variable = percentage change in urban land area			
Log of real urban land value		0.127784*** (0.0322)		0.124471*** (0.0299)
Log of real agricultural land value		−0.11958*** (0.044)		−0.06933* (0.037)
Log of real budgetary revenue per <i>mu</i>		0.160239*** (0.0235)		0.15403*** (0.3131)
<i>N</i>		723		791
<i>R</i> ²		0.3203		0.3131

Standard errors reported in parentheses. All models estimated with prefecture- and year-specific fixed effects. One *mu* is about 1/15 hectare.

* Denotes significantly different from zero at a 10 percent significance level.

** Denotes significantly different from zero at a 5 percent significance level.

*** Denotes significantly different from zero at a 1 percent significance level.

of the institutions governing primary land allocation and the theoretical analysis we constructed on the basis of that review suggest that government revenue influences the shadow price of urban land but not the profitability of land conversion. Thus, the fact that the proportional effect of changes in government revenue exceeds that of changes in urban land value suggests that local officials are, on average, more strongly motivated by growth promotion than by considerations of short run profit.

Changes in agricultural land value have nearly the same proportional effect as changes in urban land value—especially when agricultural land value is estimated using the value of agricultural output, which forms the basis for compensation for land conversion. This result suggests that two kinds of incentive-based policies might be effective alternatives to current farmland preservation policy based on the imposition of administrative restrictions. One such policy would be to increase compensation for requisitioned farmland and require that municipal governments pay that compensation from their own revenues. Another such policy would be to increase crop prices as a means of increasing compensation levels, again with the provision that compensation be paid from municipal government revenues. The latter policy would also promote farmland retention by encouraging farmers to continue farming rather than seek higher-paying work in urban areas.

6. Final remarks

Land in China is rapidly being converted from rural to urban uses as China modernizes and urbanizes. Converting land to urban uses is a typical concomitant of economic growth. Urban spatial expansion appears to have been unleashed by economic liberalization reforms, in particular, the creation of secondary markets for leasing of land use rights. But there continues to be tension between the role of market forces and bureaucratic control over land, since the primary allocation of land between urban and rural uses remains under the control of government officials subject to administrative restrictions enforced by oversight from higher government bodies in addition to the economic incentives created by liberalization. Concern over the pace and scope of land conversion

has led the central government to strengthen the administrative restrictions on land conversion.

This paper investigates conceptually and empirically the influence of economic incentives on urban spatial expansion. We use a theoretical model of primary land allocation decisions to demonstrate how municipal officials' responsibilities for promoting economic growth and managing public finances give rise to land conversion decisions and long run urban spatial sizes that respond to land values in a manner similar to those of competitive land markets with private land ownership. Our econometric study of coastal China, the fastest growing region of the country, finds that urban land values, agricultural land values, and government revenues influence changes in urban area in a manner consistent with our theoretical model. More generally, our econometric results indicate that primary land allocation decisions made by local officials are influenced by economic incentives, which implies that incentive-based policies are likely to be an effective alternative to administrative restrictions aimed at altering those land allocation decisions. The fact that proportional changes in agricultural land values have effects on changes in urban spatial growth close in magnitude that the effects of changes in urban land values suggest that increases in compensation would likely constitute effective incentives, provided that compensation is internalized by those making primary land allocation decisions.

Appendix. Short run comparative statics, long run equilibrium, and transition dynamics

We derive Results (1)–(3) by combining Eqs. (3) and (5) to get a single equation defining optimal land conversion $X(t)$ at any point in time (that is, conditional on the stock of urban land $L(t)$) and by including shifters of the value of urban land α and compensation for land conversion β , both with initial values of one:

$$\gamma[\alpha V'(X) - \beta C(1-L)] + \int_t^\infty \{R'(L) + \gamma[\tau R'(L) + \beta C'(1-L)X]\} e^{-\delta(s-t)} ds = 0 \quad (A1)$$

Differentiating Eq. (A1) holding L fixed yields:

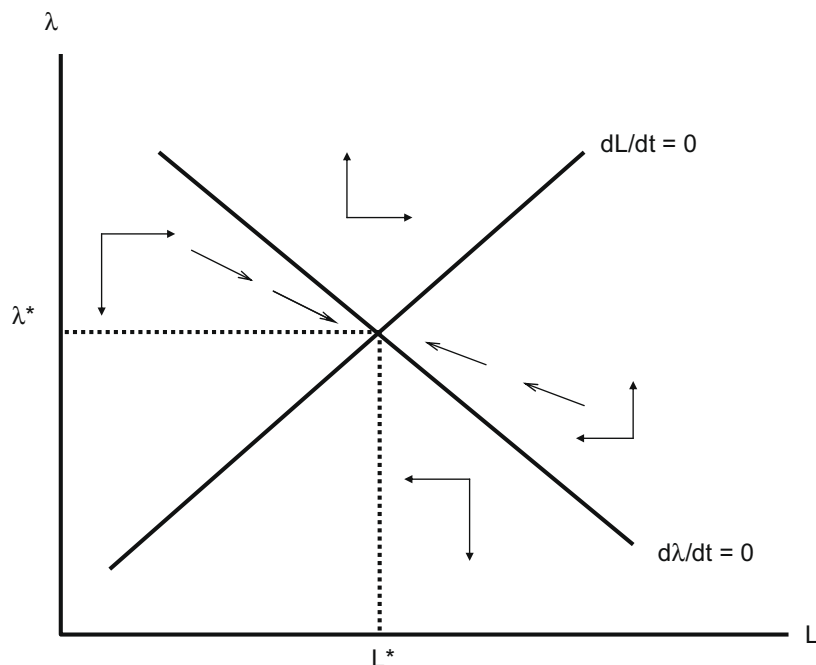


Fig. A1. Phase plane analysis of transition dynamics.

$$\frac{\partial X}{\partial \alpha} = \frac{-V'(X)}{V''(X) + \frac{1}{\gamma} C'(1-L)} > 0, \quad (A2)$$

the rate of urban spatial expansion is higher in areas where land conversion is more profitable (Result 1);

$$\frac{\partial X}{\partial \beta} = \frac{C(1-L) - \int_t^\infty C'(1-L)Xe^{-\delta(s-t)}ds}{V''(X) + \frac{1}{\gamma} C'(1-L)} < 0, \quad (A3)$$

the rate of urban spatial expansion is lower in areas where agricultural productivity (and hence compensation for land conversion) is higher (Result 2); and

$$\frac{\partial X}{\partial \tau} = \frac{-\int_t^\infty R'(L)e^{-\delta(s-t)}ds}{V''(X) + \frac{1}{\gamma} C'(1-L)} > 0, \quad (A4)$$

the rate of urban spatial expansion is higher in areas with greater expected tax revenues (Result 3).

We analyze the transition to the long run equilibrium allocation of land between urban and rural uses with a phase plane analysis in (L, λ) . Eq. (3) implicitly defines land conversion X as a function $X(L, \lambda)$ that is increasing in the shadow price of urban land ($\partial X / \partial \lambda = -1/\gamma V'' > 0$) and decreasing in the stock of urban land ($\partial X / \partial L = -C'/V'' < 0$). The long run equilibrium is thus defined as the solution to the equations

$$\dot{L} = X(L, \lambda) = 0 \quad (A5)$$

$$\dot{\lambda} = \delta\lambda - (1 + \gamma\tau)R'(L) - \gamma C'(1-L)X(L, \lambda) = 0 \quad (A6)$$

The slope of $\dot{L} = 0$ is

$$\left. \frac{d\lambda}{dL} \right|_{\dot{L}=0} = -\frac{1}{\gamma C'} > 0. \quad (A7)$$

It can be seen from Eq. (A5) that L is increasing at points above $\dot{L} = 0$ and decreasing at points below it.

The slope of $\dot{\lambda} = 0$ can be written as

$$\left. \frac{d\lambda}{dL} \right|_{\dot{\lambda}=0} = \frac{[(1 + \gamma\tau)R'' - \gamma C''X]V'' - \gamma(C'')^2}{\delta V'' + C'} < 0 \quad (A8)$$

under our concavity assumption. It can be seen from Eq. (A6) that λ is increasing at points above $\dot{\lambda} = 0$ and decreasing at points below it.

Fig. A1 depicts the phase diagram summarizing these results. Under the assumptions guaranteeing the existence of an interior solution, the long run equilibrium (L^*, λ^*) is a unique saddle point and therefore stable. Land conversion X will be positive (that is, land will be converted from rural to urban use) in a region that is initially under-urbanized ($L_0 < L^*$). Land conversion will be negative (that is, land will revert from urban to agricultural use) in a region that is initially over-urbanized ($L_0 > L^*$). In either case the rate of land conversion will decrease gradually in absolute value over time.

References

- Au, C.-C., Henderson, J.V., 2006. Are China's cities too small? Review of Economic Studies 73, 549–576.
- Cao, D., 2004. China eliminates 4800 development zones, China Daily 2004-08-24. Available from: <http://www.chinadaily.com.cn/english/doc/2004-08/24/content_368120.htm>.
- Cartier, C., 2001. 'Zone fever', the arable land debate, and real estate speculation: China's evolving land use regime and its geographical contradictions. Journal of Contemporary China 10, 445–469.
- Deng, F., 2004. Uneven land reform and urban sprawl in China: the case of Beijing. Progress in Planning 61, 211–236.
- Deng, F., 2005. Public land leasing and the changing roles of local government in China. Annals of Regional Science 39, 353–373.

- Deng, X., Huang, J., Rozelle, S., Uchida, E., 2006. Cultivated land conversion and potential agricultural productivity in China. Land Use Policy 23, 372–384.
- Deng, X., Huang, J., Rozelle, S., Uchida, E., 2008. Growth, population and industrialization, and urban land expansion in China. Journal of Urban Economics 63, 96–115.
- Ding, C., 2004. Urban spatial development in the land policy reform era: evidence from Beijing. Urban Studies 41, 1889–1907.
- Ding, C., 2007. Policy and praxis of land acquisition in China. Land Use Policy, 1–13.
- Fu, Y., Somerville, T., Gu, M., Huang, T., 1999. Land use rights, government land supply, and the pattern of redevelopment in Shanghai. International Real Estate Review 2, 49–78.
- Gaubatz, P., 1999. China's urban transformation: patterns and processes of morphological change in Beijing, Shanghai, and Guangzhou. Urban Studies 36, 1495–1521.
- Hartwick, J.M., Long, N.V., Tian, H., 2001. Deforestation and development in a small open economy. Journal of Environmental Economics and Management 41, 235–251.
- Head, K., Ries, J., 1996. Inter-city competition for foreign investment: static and dynamic effects of China's incentive areas. Journal of Urban Economics 40, 38–60.
- Ho, S.P.S., Lin, G.C.S., 2004. Converting land to nonagricultural use in China's coastal provinces. Modern China 30, 81–112.
- Hsing, Y., 2006. Land and territorial politics in urban China. The China Quarterly 187, 575–591.
- Investigating Group of Ministry of Land and Resources, 2003. Overall report of land acquisition reform research project, In: Lu, S., (Ed.), Yanjiu ZhengDi WenTi TaoShuo GaiKe ZhiLu, vol. 2. Zhongguo DaDi Press (examining land acquisition problems—reform path seeking, China Land Press).
- Jin, H., Qian, Y., Weingast, B., 2005. Regional decentralization and fiscal incentives: federalism, Chinese style. Journal of Public Economics 89, 1719–1762.
- Li, H., Zhou, L.-A., 2005. Political turnover and economic performance: the incentive role of personnel control in China. Journal of Public Economics 89, 1743–1762.
- Lichtenberg, E., Ding, C., 2008. Assessing farmland protection policy in China. Land Use Policy 25, 59–68.
- Lin, G.C.S., 2001. Metropolitan development in a transitional socialist economy: spatial restructuring in the Pearl River Delta, China. Urban Studies 38, 383–406.
- Lin, G.C.S., 2007. Chinese urbanism in question: state, society, and the reproduction of urban spaces. Urban Geography 28, 7–29.
- Lin, G.C.S., Ho, S.P.S., 2005. The state, land system, and land development processes in contemporary China. Annals of the Association of American Geographers 95, 411–436.
- Lin, J.Y., Liu, Z., 2001. Fiscal decentralization and economic growth in China. Economic Development and Cultural Change 49, 1–21.
- Liu, S., 2005. Land policy and urban spatial expansion financing, presented at workshop organized by the Development Research Center of P.R. China, Beijing, January 16 2005.
- National Bureau of Statistics, China Statistical Yearbook 2006, Beijing.
- Peterson, G.E., 2006. Land leasing and land sale as an infrastructure-financing option, World Bank Policy Research Working Paper 4043, Washington, DC.
- Ping, X., 2006. Evaluation of the performance of China's local budget system, working paper, China Center for Economic Research, Peking University.
- Seto, K.C., Kaufman, R.K., 2003. Modeling the drivers of urban land use change in the Pearl River Delta, China. Land Economics 79, 106–121.
- Tan, M., Li, X., Xie, H., Lu, C., 2005. Urban land expansion and arable land loss in China—a case study of Beijing-Tianjin-Hebei region. Land Use Policy 22, 187–196.
- Turnbull, G.K., 2007. Urban growth controls: transitional dynamics of development fees and growth boundaries. Journal of Urban Economics 55, 215–237.
- Wong, C., Bhattasali, D., 2003. China: National Development and Sub-national Finance. CITIC Publishing House.
- Wu, F., 1998. Polycentric urban development and land-use change in a transitional economy: the case of Guangzhou. Environment and Planning A 30, 1077–1100.
- Wu, F., Yeh, A.G.O., 1997. Changing spatial distribution and determinants of land development in China's transition to a market economy: the case of Guangzhou. Urban Studies 34, 1851–1879.
- Yang, C., Wu, C., 1996. Zhong Guo Tu Di Shi Yong Zhi Du Gai Ge Shi Nian (Ten-Year Reform of Land Use System in China), Zhong Guo Da Di Publisher, Beijing, 1996.
- Yeh, A.G.O., Li, X., 1999. Economic development and agricultural land loss in the Pearl River Delta, China. Habitat International 23, 373–390.
- Zhang, B., Liu, X., 2003. China Taxation Report 2001–2002, China. Taxation Press.
- Zhang, Z., Martinez-Vazquez, J., 2003. The system of equalization transfers in China, working paper, International Studies Program, Georgia State University.
- Zhang, T., Zhou, H., 1998. Fiscal decentralization, public spending, and economic growth in China. Journal of Public Economics 67, 221–240.
- Zhou, Y., Ma, L.J., 2000. Economic restructuring and suburbanization in China. Urban Geography 21, 205–236.
- Zhu, J., 2005. A transitional institution for emerging land markets in China. Urban Studies 8, 1369–1390.