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 recent years. A theoretical analysis demonstrates how recent fiscal and governance reforms give rise to land conversion decisions and long run urban spatial sizes much like those generated by competitive land markets with private land ownership. An econometric investigation of Shanghai and the provinces surrounding it demonstrates the presence of rent gradients, often used as an indication of the presence of land markets. It thus appears that economic forces have continued to exercise dominant influence over primary land allocations in spite of recent administrative restrictions on land conversion. These rent gradients are strongest in the most economically developed portions of the study region and weakest in the least economically developed. Urban land values exceed agricultural land values by a considerable margin, suggesting that rates of urbanization will continue to be rapid. The estimated rent gradients also suggest that much of this region will eventually become completely urbanized.

JEL Codes: R5, R14, H11, O18

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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 (Cody 2004, 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 like 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 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, with an emphasis on Shanghai and its environs, one of the fastest growing regions 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 decisions 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 the extent to which economic incentives have shaped urban land use in Shanghai and the provinces surrounding it. We take as an indicator of the influence of economic incentives the presence of rent gradients, which urban areas in planned economies (like China historically) typically lack (Bertaud and Renaud 1997). An econometric study of transaction prices for long term leases of land by Ding (2004) provides some evidence that rent gradients characteristic of land markets have appeared in Beijing. We estimate the values of urban and rural land indirectly, using polycentric city models of the contributions of land and other factors of production to urban and agricultural GDP at the county level. The estimated models provide evidence of the presence of rent gradients characteristic of land markets, suggesting that economic and governance reforms together have allowed economic incentives to determine land use despite formal public ownership and control over primary allocations of land. Finally, we use those estimated rent gradients to discuss the likely future extent of urban spatial expansion in the greater Shanghai economic zone of influence.

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 year) 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 those 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. Performance in fostering economic growth is thus 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

[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

retain all profits from land transactions. The evidence available indicates that many localities rely heavily on land transactions to finance both ongoing obligations 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, Long, and Tian (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 1-L(t) the share devoted to agriculture during that period. The change in the stock of urban land at any time t is

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

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).

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.

We assume 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 those rewards

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

subject to the state equation (1) and an initial condition on the amount of land in urban uses, $L(0) = L_0$. The initial amount of land in agriculture likely exceeds 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 λ(t) 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:

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

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

plus the state equation (1) and the initial condition on urban land. Equation (3) indicates that local officials' land conversion decisions are motivated by both short run profit from land transactions V′(X)-C(1-L) and by the long run value of adding to the stock of urban land, represented by its shadow price λ(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 equation (4) to get:

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

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 γ[τR′(L)+C′(1-L)X], which is positive as long as tax revenues from increased economic activity in the urban area τR′(L) exceed the increase in compensation for requisitioned agricultural land caused by the rising scarcity of agricultural land C′(1-L)X.

Differentiating equation (3) 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 when the differential between the values of urban and agricultural land is greater ($\partial X/\partial\lambda = -1/\gamma V'' > 0$).

Result 2. The rate of urban spatial expansion slows as the urbanized share of the region increases ($\partial X/\partial L = -C'/V'' < 0$).

Result 3. The rate of urban spatial expansion is higher in urban areas experiencing greater financial pressure ($\partial X/\partial\gamma = -\lambda/\gamma V'' > 0$).

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

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

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

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

$F(L)$ is monotonically decreasing in L ($F'(L) = (1+\gamma\tau)R''(L)/\gamma\delta+C'(1-L) < 0$), so if $F(0) > 0$ and $F(1) < 1$, 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 (unweighted) present value of rent generated by urban land at the margin $R'(L)/\delta$ 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 similar to those arising out of a 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.

5. Land Allocation in the Greater Shanghai Region

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. Ideally, such a 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 transactions 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. Given this lack of data, we investigate land allocation indirectly by estimating the values of urban and agricultural land implicitly.

5.1 Data

Our empirical study focuses on Shanghai and the four provinces in its immediate economic zone of influence (Jiangsu, Zhejiang, Anhui, Jiangxi) during the period 1996-2004. We restricted our analysis to the time period beginning in 1996, the first year in which reliable land use data are available. We obtained a panel of time-series cross-section data from two sources. Data on land area in cities, towns, various kinds of transportation infrastructure (highways, rural roads, railroads) as well as land planted to major crops ("cultivated land") and horticultural crops in each county in this region came from records maintained by China's Ministry of Land and Resources, which collects that information from its local subordinates on an annual basis. Economic and demographic data for that same time period came from provincial statistical yearbooks for the years 1997-2005. Data reported at the county level included GDP (measured as value added) in total and by sector (primary, secondary, and tertiary), measured in RMB 10,000; population (total, agricultural, and non-agricultural) in each year, measured in 10,000 persons; realized foreign direct investment, measured in US$10,000[2]; and government expenditures, measured in RMB 10,000. All monetary variables except foreign direct investment were converted to constant 2005 price levels using the fixed price consumer price index reported by China's National Bureau of Statistics (2006). There were 300 counties and urban districts with usable data in this region. Descriptive statistics of the data used are given in Table 1.

5.2 Specification and Estimation of the Econometric Model

As is standard, we assume that GDP in either the urban or rural sector in county j at time t (Y_{jt}) is a function of land (L_{jt}), labor force size (N_{jt}), capital (K_{jt}), infrastructure (G_{jt}), and unobserved factors unique to each county (H_j):

$$Y_{jt} = F(L_{jt}, N_{jt}, K_{jt}, G_{jt}, H_j) . \qquad (8)$$

Our data contain information on investment flows rather than stocks of capital or infrastructure. To accommodate those data, we use a transformed relationship derived from a first-order approximation to equation (8) around the preceding period's input levels:

$$\Delta Y_{jt} = F_L \Delta L_{jt} + F_N \Delta N_{jt} + F_K \Delta K_{jt} + F_G \Delta G_{jt} + u_{jt} , \qquad (9)$$

[2] Foreign direct investment was not reported for all (especially earlier) years in some cities. Visual examination of the data showed that foreign direct investment in these cases was quite small in subsequent years, hence foreign direct investment was set to zero whenever it was not reported.

where u_{jt} represents the approximation error and ΔK_{jt} and ΔG_{jt} are, respectively, current investment in physical and infrastructure capital. This specification nets out all unobserved county characteristics that remain constant over time H_j.

We used GDP in secondary and tertiary industry to measure the value of urban economic output and GDP in primary industry to measure the value of agricultural output. We used the size of the non-agricultural population as a proxy for the size of the urban labor force and the size of the agricultural population as a proxy for the size of the agricultural labor force since reliable employment data were not available. We used land in highways, rural roads, and railroads as measures of transportation infrastructure and current local government expenditure as measures of current investment in other forms of physical and institutional infrastructure.

We assumed a polycentric city structure for the region, with centers located in Shanghai, Hangzhou (the capital of Zhejiang Province), Hefei (the capital of Anhui Province), and Nanchang (the capital of Jiangxi Province). We omitted a central city for Jiangsu Province because the most prosperous, highest-growth counties are quite close to Shanghai while the provincial capital, Nanjing, is on the border of Anhui Province. We incorporated a polycentric city structure by making the marginal product of both urban and agricultural land a function of the distance from the centroid of each county to the centroid of the closest major urban center. We estimated two specifications of this model: One that restricted the value of land in each urban center and the rent gradient to be the same for all urban centers and another that allowed both the value of land in each urban center and the rent gradient associated with that urban center to vary across urban centers. The estimating equations of the unrestricted model thus took the form

$$\Delta Y_{jt} = b_0 + \left(\sum_k \left(b_{1k} + b_{2k} d_{jk} \right) I_{jk} \right) \Delta L_{jt} + b_3 \Delta N_{jt} + b_4 \Delta K_{jt} + b_5 \Delta G_{jt} + u_{jt} \qquad (10)$$

where I_{jk} is an indicator taking on a value of 1 if urban center k is the closest urban center to county j and zero otherwise. The estimating equations of the restricted, aggregated model set $b_{1k} = b_1$ and $b_{2k} = b_2$ $\forall$ k. The coefficients of the interaction between distance and the change in cultivated land were not significantly different from zero in the agriculture sector model, however, and were thus omitted from both specifications of that model.

As noted above, first differencing nets out all unobserved county characteristics that remain constant over time. There may, however, be unobserved year-specific factors influencing the value of output such as weather or market conditions. A Hausman test indicated that the hypothesis of no correlation between the error term u_{jt} and the variables included in the regression model could not be rejected at any reasonable level of significance in the urban sector model (the p-value of the test statistic for the disaggregated model was 0.9514). The opposite was true of the agriculture sector model (the p-value of the test statistic for the disaggregated model was 0.0002), so we estimated the urban sector model using a year-specific random effects generalized least squares estimator and the agriculture sector using year-specific fixed effects. The estimated coefficients of these models and their associated standard errors are given in Table 2.

5.3 Results

The urban sector model fit the data quite closely, as indicated by a very high R^2 and the fact that most of the coefficients were significantly different from zero at a 5% significance level or better. The agriculture sector model did not fit the data as closely, despite the use of year-specific fixed effects. Nevertheless, the coefficients of several key variables of interest in this model were significantly different from zero at a 5% significance level or better.

5.3.1 Urban and Agricultural Land Values

The coefficient of land in the urban sector model b_{1k} should equal the marginal value of land at the center of major urban center k while the coefficient of the cross-product of land and distance in this model should equal the rent gradient associated with that major urban center. The coefficient of cultivated land in the agriculture sector model b_{1k} should equal the marginal value of farmland in the counties closest to major urban center k. These coefficients can be used in several ways. First, the strength of the rent gradient b_{2k} is an indication of the extent to which primary land allocation is determined by economic incentives, since land allocation in planned economies is distinguished by their lack (Bertaud and Renaud 1997). Second, the rent gradient b_{2k} along with the central city coefficient b_{1k} can be used to find the implicit urban-rural boundary for each major urban center defined by the equality of the marginal value of land in the urban and agricultural sectors, hence the likely long run extent of urbanization. Third, the difference between the coefficients of land in the urban and agricultural sectors b_{1k} givens an indication of the short term returns from requisitioning rural land for conversion to urban uses and hence the strength of incentives for urban spatial expansion.

Consider first the urban model. The coefficients of the change in land in cities in the urban sector model were significantly different from zero in both specifications. These coefficients indicate that the marginal value of land in the urban sector is quite high in this region, as one would expect for one of the fastest growing parts of China. At an exchange rate of 8 RMB per dollar, the average marginal value of land in cities overall in this region was about $516,000 per hectare ($209,720 per acre). As expected, the marginal value of land was highest in Shanghai ($893,000 per hectare or $362,940 per acre), followed closely by Hangzhou ($738,000 per hectare or $299,850 per acre). The marginal values of land in Nanchang ($362,000 per hectare or $88,310 per acre) and Hefei ($217,000 per hectare or $147,160 per acre) were substantially lower, as one would expect for the capitals of much poorer provinces.

The urban model also shows the presence of rent gradients, especially in the most developed portions of this region. The coefficients of the cross-product of the change in land in cities and distance to the closest major urban center were all significantly different from zero in the urban sector models. The marginal value of land in the region overall declined at an average rate of 0.11 RMB per mu per kilometer of distance from the nearest major urban center. The rent gradients in counties closest to Shanghai and Hangzhou were much higher (-0.25 and -0.15 per mu or $4608 and $2761 per hectare per kilometer of distance, respectively) than those associated with Nanchang and Hefei (-0.09 and -0.04 per mu or $1760 and $840 per hectare per kilometer of distance, respectively), suggesting that land markets are more highly developed in the former than in the latter (Bertaud and Renaud 1997, Ding 2004).

The coefficients of the change in cultivated land were significantly different from zero in the agricultural models, with the exception of counties closest to Hangzhou. As expected, the marginal value of land in agricultural uses was much lower than the marginal value of land in urban uses: At an exchange rate of 8 RMB per dollar, the marginal value of agricultural land was $900 per hectare ($370 per acre) in the region overall, $1200 per hectare ($500 per acre) in counties closest to Shanghai, $500 per hectare ($210 per acre) in counties closest to Hangzhou, $2500 per hectare ($1030 per acre) in counties closest to Nanchang, and $650 per hectare ($270 per acre) in counties closest to Hefei.

The estimated disparity in the marginal value of land in agriculture and urban uses is enormous: The marginal value of land in cities is over 570 times the marginal value of land in agriculture in the region overall; the disparity ranges from about 140 times in Nanchang to 1450 times in Hangzhou. These estimates suggest that the incentives for converting agricultural land to urban uses are extremely strong, i.e., that the potential short term profits and the long-term economic growth from land conversion are extremely large. Moreover, the implicit rural-urban boundaries for these major urban centers, given by the distances that equalize the marginal values of land in the urban and agricultural sectors (Table 3), are quite large, suggesting that the incentives for converting rural land to urban uses remain quite strong far outside current city limits. The arbitrage opportunities generated by such disparities are so large that it seems extremely unlikely that administrative measures will suffice to control land conversion: With such substantial gains at stake, one would expect local officials to find ways of converting rural land to urban uses regardless of any administrative restrictions in place.

The estimated parameters of the disaggregated urban and agriculture sector models can be used to characterize the equilibrium polycentric city structure current economic incentives appear to be generating. The implicit boundary between the Shanghai and Hangzhou urban areas (given by the distance that equates the marginal value of land in the two) is about halfway between the two cities while the implicit urban-rural boundary for both cities exceeds the distance between them (Table 3), suggesting that the entire Shanghai-Hangzhou corridor is moving toward complete urbanization. The implicit boundaries between the Hangzhou and Hefei and Hangzhou and Nanchang urban areas, in contrast, both exceed the implicit rural-urban boundaries, suggesting that some land in these corridors will remain in agricultural use.

The coefficient of land in cities in the agricultural models are positive but not significantly different from zero, suggesting that conversion of land from rural to urban uses has not impaired agricultural productivity in this region. This result confirms the conclusions reached by other studies that new crop varieties, improvements in technology, and substitution of capital, energy, and chemicals for land and labor should suffice to ensure China's continued food security (Lichtenberg and Ding 2008, Deng et al. 2006).

The coefficient of land in designated towns is not significantly different from zero in any of the urban or agricultural models, suggesting that town land adds little, if anything, to economic growth in this region.

5.3.2 The Value of Infrastructure

The coefficients of land in railroads, highways, and rural roads measure the marginal value of returns to physical investments in infrastructure. Like Demurger (2001) and Fan and Zhang (2004), we find that certain kinds of infrastructure investment contribute substantially to economic growth in China. The coefficients of land in highways suggest that both the urban and agricultural sectors benefit from investments in highways. The marginal value of land in highways is on the order of \$237,000 to \$273,000 per hectare in the urban sector. It is considerably lower in the agricultural sector, only on the order of \$10,000 to \$11,000 per hectare. Railroads benefit the agricultural sector: the marginal value of land in railroads is on the order of $54,000 to $58,000 per hectare. They do not appear to benefit the urban sector: The coefficient of land in railroads is actually negative, albeit not significantly different from zero, raising the possibility that investment in railroads actually detracts from urban economic performance. Finally, the coefficient of land in rural roads is not significantly different from zero in any of the urban or agriculture sector models, indicating that investment in rural roads does not improve economic performance in either the urban or the agricultural sector.

5.3.3 The Value of Labor

The coefficient of population should equal the marginal value of labor. The coefficient of non-agricultural population size is positive and significantly different from zero in both urban sector models. It is roughly the same in both models, on the order of 15,330-15,370 RMB. It is also roughly equal to the average wage rate in this region, which, according to data reported at the prefecture level, was 16,570 RMB in 2004 and ranged from 12,800 RMB in Anhui and Jiangxi Provinces to 24,400 in Shanghai that same year.

The value of labor was much lower in the agricultural sector, only 205 to 210 RMB per person. Moreover, the coefficient of agricultural population was significantly different from zero only in the aggregate model and then only at a 10% significance level. The lack of significance of the coefficient of agricultural population may indicate the presence of surplus labor in this sector; it is also possible, however, this coefficient understates the marginal productivity of labor since it includes population both in and out of the active workforce.

5.3.4 Return to Foreign Direct Investment

Foreign direct investment is believed to be more productive than domestic investment because it introduces new technologies and new production methods that enhance human capital and because it induces host governments to make additional investments in infrastructure (Chen and Warner, 1996, Zhang and Zhou 1998, Lin and Liu 2000, Fujita and Hu, 2001, Zhang 2001, Gao, 2003). The coefficient of foreign direct investment should equal the composite rate of return to the combination of physical capital, new technologies, and human capital provided by foreign direct investment.

The coefficient of realized foreign direct investment is positive and significantly different from zero in both urban sector models. At an exchange rate of 8 RMB per US dollar, the estimated coefficients imply a rate of return on foreign direct investment on the order of 15 to 18%, somewhat higher than the 10 to 12% rate of return estimated by Lin and Song (2002) for 189 major Chinese cities during the period 1991-1998 and somewhat lower than the 31% rate of return estimated by Zhang (2001) using provincial data for the period 1984-1998. These results support the notion that foreign direct investment generates spillover effects from new technologies, enhancement of human capital from exposure to more advanced production methods, and institutional and infrastructure improvements required to maintain inflows of foreign capital and indicate that these spillover effects are substantial.

In contrast to the urban sector models, the coefficient of realized foreign direct investment in both agriculture sector models is small and not significantly different from zero, suggesting that foreign direct investment does not have an adverse effect on agricultural productivity.

5.3.5 Return to Government Expenditure

The coefficient of government expenditure can be considered as a measure of the rate of return on government investment in physical and institutional infrastructure. The rate of return on these investments appears to be quite high in the urban sector. Since this variable includes spending on social services as well as investment in physical and institutional infrastructure, the rate of return on infrastructure likely exceeds the 54 to 56 percent implied by this coefficient. In contrast, the rate of return on government expenditure in the agricultural sector is extremely low, less than one percent and not significantly different from zero.

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 extent to which market forces have been determining urban spatial expansion in Shanghai and the provinces in its immediate economic zone of influence, one of the fastest growing regions in China.

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 much like those generated by competitive land markets with private land ownership. Our econometric study demonstrates the presence of rent gradients, often used as an indication of the workings of land markets. It thus appears that economic forces have continued to exercise dominant influence over primary land allocations in spite of attempts to restrict their operation by administrative means, suggesting that China should consider incentive-based rather than bureaucratic policies if it is truly interested in limiting urban spatial expansion. As expected, these rent gradients are strongest in the most economically developed portions of the study region, the areas closes to Shanghai and Hangzhou, and weakest in the least economically developed portions of the study region, the areas closest to Nanchang and Hefei. Urban land values exceed agricultural land values by a considerable margin, suggesting that rates of urbanization will continue to be rapid in this region. The estimated rent gradients also suggest that the corridor between Shanghai and Hangzhou will eventually become completely urbanized.

Appendix: Long Run Equilibrium and Transition Dynamics

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). Equation (3) implicitly defines land conversion X as a function X(L,λ) with properties described in Results 1-3. The long run equilibrium is thus defined as the solution to the equations

$$\dot{L} = X(L,\lambda) = 0 \tag{A1}$$

$$\dot{\lambda} = \delta\lambda - (1+\gamma\tau)R'(L) - \gamma C'(1-L)X(L,\lambda) = 0 \tag{A2}$$

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

$$\left.\frac{d\lambda}{dL}\right|_{\dot{L}=0} = -\frac{1}{\gamma C'} > 0\,. \tag{A3}$$

By Result 1, L is increasing at points above $\dot{L} = 0$ and decreasing at points below it.

Using Results 1-3, the slope of $\dot{\lambda} = 0$ can be written

$$\left.\frac{d\lambda}{dL}\right|_{\dot{\lambda}=0} = \frac{[(1+\gamma\tau)R'' - \gamma C''X]V'' - \gamma(C')^2}{\delta V'' + C'} < 0 \tag{A4}$$

under our concavity assumption. By Result 1, λ is increasing at points above $\dot{\lambda} = 0$ and decreasing at points below it.

Figure 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.

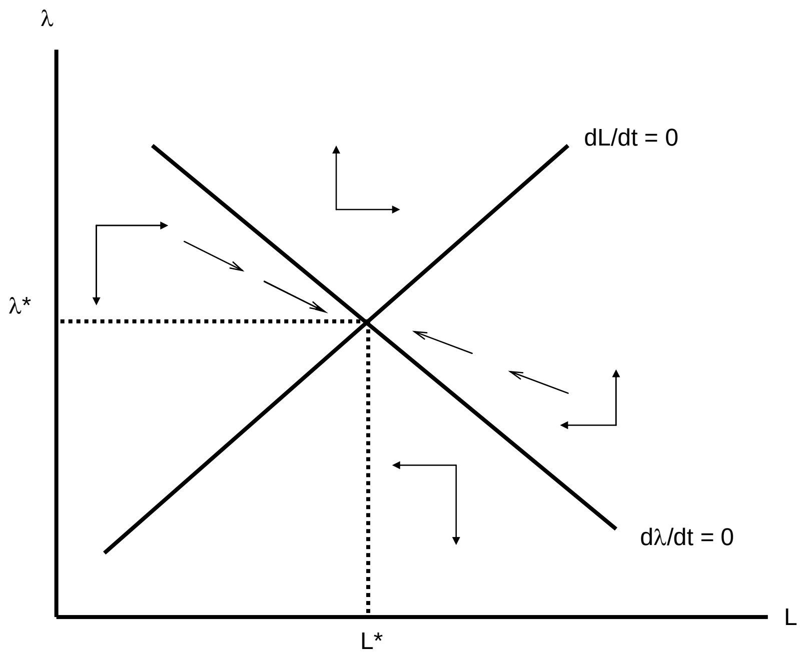

Figure A1. Phase Plane Analysis of Transition Dynamics

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Table 1. Descriptive Statistics of the Data Used in the Analysis

Variable	Mean	Standard Deviation	Minimum	Maximum
Real urban GDP (10,000 2005 RMB)	84726.27	368402.6	-183155	9727798
Real agricultural GDP (10,000 2005 RMB)	3381.32	11893.47	-74477.3	126654.6
Change in city land (mu)	459.9242	2851.31	-40789.1	60883.7
Distance to the nearest major urban center (km)	173.8826	90.80466	0	456.6606
Change in land in designated towns (mu)	287.0056	6129.61	-232436	38533.1
Change in cultivated land (mu)	-4129.77	22288.49	-409375	395442.8
Change in horticultural land (mu)	7.778489	6646.02	-61314.9	102736.4
Change in land in railroads (mu)	26.13732	222.5068	-3444.1	3036.8
Change in land in highways (mu)	607.7614	1853.61	-10743.3	45682.3
Change in land in rural roads (mu)	-43.8577	2932.39	-89108.2	18919.5
Change in non-agricultural population (10,000 persons)	0.787919	2.408592	-10.03	56.21
Change in agricultural population (10,000 persons)	-0.24539	2.338936	-45.59	27.04
Realized foreign direct investment ($10,000)	4925.8	32209.94	0	741000
Real government expenditures (10,000 2005 RMB)	71902.93	505524.5	2176.03	14208029
Closest major urban center is Shanghai	0.10802	0.310478	0	1
Closest major urban center is Hangzhou	0.267965	0.443002	0	1
Closest major urban center is Nanchang	0.32777	0.469509	0	1
Closest major urban center is Hefei	0.296245	0.456706	0	1

Table 2. Estimated Parameters of Urban and Agricultural GDP Panel Data Models

Variable	Real Urban Sector GDP		Real Agricultural GDP	
Change in land in cities	27.51473*** (1.6057)		0.09882 (0.0871)	0.065333 (0.0898)
Counties closest to Shanghai		47.61791*** (6.8779)		
Counties closest to Hangzhou		39.34065*** (2.3679)		
Counties closest to Nanchang		19.30719** (8.0573)		
Counties closest to Hefei		11.58618*** (2.4764)		
Cross-product of change in land in cities and distance to closest urban center:	-0.10949*** (0.00790)			
Counties closest to Shanghai		-0.24574*** (0.0440)		
Counties closest to Hangzhou		-0.14726*** (0.0191)		
Counties closest to Nanchang		-0.09388** (0.0440)		
Counties closest to Hefei		-0.04482*** (0.0109)		
Change in cultivated land			0.04805*** (0.0120)	
Counties closest to Shanghai				0.064622*** (0.0224)
Counties closest to Hangzhou				0.026962 (0.0403)
Counties closest to Nanchang				0.135058*** (0.0456)
Counties closest to Hefei				0.0348** (0.0149)
Change in horticultural land			-0.04228 (0.0367)	-0.05231 (0.0374)
Change in land in designated towns	0.351757 (0.04252)	-0.18124 (0.4223)	0.007542 (0.0499)	0.005597 (0.0505)
Change in land in railroads	-15.5865 (9.5020)	-5.11239 (9.4369)	3.097389*** (1.1257)	2.880223** (1.1305)
Change in land in highways	14.58075*** (1.4236)	12.65465*** (1.4297)	0.559062*** (0.1673)	0.579789*** (0.1692)
Change in land in rural roads	-0.45817 (0.7016)	-0.51718 (0.6956)	-0.00726 (0.0839)	0.002493 (0.0842)
Change in population	15370.68*** (1156.4)	15330.84*** (1143.4)	204.9718* (123.3)	210.0018 (126.0)

Realized foreign direct investment	1.423609*** (0.1588)	1.213104*** (0.1645)	0.025209 (0.0194)	0.027292 (0.0197)
Real government expenditures	0.555399*** (0.0111)	0.543129*** (0.0109)	0.000578 (0.00128)	0.000449 (0.00130)
Year-specific effects	Random	Random	Fixed	Fixed
Number of observations	2157	2157	2157	2157
R^2	0.9351	0.9376	0.1229	0.1251

Standard errors shown in parentheses. *** denotes significantly different from zero at a 1% level, ** denotes significantly different from zero at a 5% level, * denotes significantly different from zero at a 10% level.

Table 3. Implicit Equilibrium Inter-Urban and Urban-Rural Boundaries

	Shanghai	Hangzhou	Nanchang	Hefei	Agricultural Land
Actual Inter-Urban Distances					
Shanghai	0	166	603	397	
Hangzhou		0	445	325	
Nanchang			0	375	
Hefei				0	
Implicit Boundaries					
Shanghai	0	84	186	179	194
Hangzhou		0	375	271	267
Nanchang			0	157	204
Hefei				0	258

Implicit boundaries determined by equality of marginal land values as calculated from coefficients of the disaggregated urban and agricultural sector models.