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Economic transition and urban land expansion in Provincial China

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ABSTRACT

China has undergone economic transition characterized by marketization, globalization and decentralization, which has resulted in profound change in land use and urban space. This paper integrates globalization, institutional change, and China's economic transition to better understand urban land expansion in China. We use land use survey data in Jiangsu province at the county level to shed the light on the impact of economic transition on land use change and urban land expansion in China. We have found that a dramatic land use change in Jiangsu characterized by rapid urban land expansion, particularly Sunan (Southern Jiangsu) and municipal districts. This can be well explained by government policies including tax reform and intergovernmental competition, the participation in the global economy, and the development of a market economy. We have also found that urban land expansion has a temporal dimension, and was driven mainly by local governments in the early stage of the reform, followed by marketization, and more recently globalization after China's entry into the World Trade Organization (WTO).

Introduction

Land use change is seen as an interaction between the human and natural subsystems, and urban expansion has become a global phenomenon. The International Geosphere Biosphere Programme (IGBP) and the International Human Dimensions Programme (IHDP) jointly created a research agenda dealing with Land-Use/Cover Change (LUCC) in 1995, which has since become a forefront of research on global change (Turner, Meyer, & Skole, 1994). Scholars have recorded a rapid process of urbanization and urban land expansion in developing countries, and understanding the driving mechanisms has attracted considerable research interest (Turner, Lambin, & Reenberg, 2007; Zhu, 2013). With heighted globalization, land use change has become more complicated, and is no longer a local, physical process supposed to be mainly influenced by accessibility and the physical environment; land use change is influenced by global processes and institutional change (Luo & Wei, 2009; Wei & Ye, 2014). Foreign capital often finances "land grabs," and scholars have proposed the urban land teleconnections (ULT) framework to advance conventional conceptualization of urbanization and land (Güneralp, Seto, & Ramachandran, 2013). They have also promoted using economic geography to reinvigorate land-use science (Munroe, McSweeney, Olson, & Mansfield, 2014). This paper is one of such recent efforts to integrate globalization, institutional change, and China's economic transition to better understand urban land expansion in China.

As one of the biggest developing countries, China's economic transition has caused rapid urbanization and land use change, imposing serious challenges for food security, social conflicts and economic polarization, and thus generating considerable governmental concerns and scholarly attention (Anderson & Ge, 2004; Bai, Shi, & Liu, 2014; Long, Zou, Pykett, & Li, 2011; United Nations, 2001). Most of the studies on land use have focused on the "hot spots" of urbanization and urban land expansion such as coastal cities, and ecologically fragile areas in western China. Using satellite remote sensing and land use statistics, they found that regional land use structure in China has been undergoing considerable changes, particularly in those relatively developed provinces (Li, Ma, Xu, Wang, & Zhang, 2009; Lin & Ho, 2003; Wu & Yeh, 1997; Zhao et al., 2013). And a large portion of rural and unused land (e.g. the water areas, wasteland etc.) had been developed in the past 20 years (Liu, Zhan, & Deng, 2005; Liu et al., 2010).

Scholars have also explored underlying driving forces of urban land expansion and classified the key factors of land use change into natural and socio-economic driving forces. Natural features

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such as geology, geomorphology, elevation and slope are seen as the basic conditions of land use change (Verburg, Van De Steeg, Veldkamp, & Willemen, 2009); population growth, economic development (particularly non-agricultural economies) as well as income disparities constitute the main driving forces of land use change (Liu, Yue, & Fan, 2011; Ojima, Galvin, & Turner, 1994; Rudel et al., 2005). It is also argued that land use changes have primarily resulted from people's pursuit of increasing labor productivity in changing environment (Zhu, 2013). Skyrocketing land prices and values have triggered the "profitable" land conversion from agricultural use to non-agricultural activities, making land the frontier of social conflicts in urban China (Ding & Lichtenberg, 2011). More efforts are still needed to examine land use change or restructuring with the key transition characteristics, including China's opening door policy, tax-sharing reform, and the improvement of its market institutions. A better understanding of various driving forces of land use change in different development periods is necessary to cope with rapid urbanization and sustainability challenges in China (Wei & Ye, 2014).

This paper attempts to build a conceptual framework for the analysis of land use change during the transition era within the context of the triple process of China's economic transition, namely marketization, globalization and decentralization. We conduct a finer scale analysis of land use change in Jiangsu province, a typical coastal province in China covering an area of 102,600 km^2, with a population of 79.2 million in 2012 (Fig. 1). Jiangsu is one of China's most developed provinces with the fastest economic growth and the highest marketization level in China. In 2012, the overall GDP of Jiangsu was 5406 billion yuan. As one of the traditionally densely populated and highly intensive land use regions that have experienced rapid economic growth and spatial restructuring, Jiangsu is also highly typical of evolution of the human–land relationship caused by land use change (e.g. the loss of arable land and the expansion of construction land) throughout China.

Research background: economic transition and urban land expansion

Land is an important resource for human development, and land use reflects the most direct reaction of mutual influence and interaction between the humanistic and natural subsystems. Moreover, it has been argued that the progress of globalization itself may affect land use change through enlarging or reducing the effects of local factors (Lambin & Geist, 2001; Lambin & Meyfroidt, 2011; Turner et al., 1994). China's economic transition, which can be conceptualized as a triple process of marketization, globalization, and decentralization (Wei, 2001; Wei & Li, 2002) has greatly impacted its urbanization, land use and regional development both directly and indirectly. China's economic reforms have empowered growth-oriented local governments and urban land has become a central concern of governmental officials for local economic growth and even rent seeking (Ding & Lichtenberg, 2011; Wei, 2012). As a result, government, not simply the marketplace, has a responsibility for land use change, because urban development and specialization is neither happenstance nor controlled by the market, rather is influenced by state priorities for certain types of development (Liao & Wei, 2014; Zhang, 2000). The growing concern over China's international competitiveness under globalization forces the state to make constant institutional changes to accommodate the interests of the private sector and foreign investors (Lin & Ho, 2005). Thus policy, regulation, and the state system have brought

Fig. 1. Jiangsu province.

about the most significant influences on urban expansion and land use change in China (Lai et al., 2008; Lin & Ho, 2005; Wei & Ye, 2014; Wu & Yeh, 1997; Yue, Fan, & Wei, 2014).

As illustrated in Fig. 2, the establishment of the market economic system has accelerated the distribution of land and the flow of capital, labor and other production elements, which has, in turn, changed the process of land development in Chinese cities. Coincidentally, the opening door policy has stimulated the growth of foreign direct investment (FDI). Development zones and industrial parks are the most popular destinations, and have also restructured urban space (Liu et al., 2005; Ma, 2004). Meanwhile, the tax reform established in 1994 decentralized fiscal responsibilities and intensified the fiscal pressure of local governments. A local municipal government is now required to source its own funding for infrastructure projects, schools, and most of its welfare programs. The financial pressure on municipal government is, therefore, growing significantly (Zhang, 2000). What's more, the growth of urban population, an enormous demand for housing and increasing construction activities have pushed local governments to acquire more land for development. Thus, both "push" and "pull" forces have driven local government to restructure land use patterns and occupy arable land for urban development (Zhang, 2000).

Marketization, urban expansion and land use change

In Western economies, land allocation can be described as a process of land conversion from its original use to a more valuable use (Barlowe, 1978). However, under the socialist state, land in China was previously considered a means of production rather than an asset, given its 'ownership' by states in the era of centrally controlled planning (Zhu, 2004). The allocation of production elements was largely a result of state planning, with the market playing almost no role in the organization of land use patterns (Lin & Ho, 2005; Shen, Feng, & Wong, 2006).

Since the economic reforms in the late 1970s, China has undergone a dramatic change in land use patterns (Pannell, 2002). In particular, the shift in its ideological emphasis away from egalitarianism to comparative advantage has given rise to the spectacular expansion of cities and towns, as well as development zones on the eastern coast (Lin & Ho, 2003). Given this context, market reform has affected land use change in China in three major ways. First, capital, labor and land become commoditized, meaning that the market gradually became a major determinant of allocation decisions (Wei & Li, 2002). To some extent, this market-oriented reform promoted rural to urban migration and helped small and medium-sized enterprises to obtain more capital; both increased market demand for land in the late 1980s. Second, relaxed state control over the rural economy allowed farmers to reallocate land away from food grain production to horticulture that promises better profits; arable land, forest, and other landscape in the urban fringe areas drastically degraded, resulting in a massive amount of construction land expansion (Lin & Ho, 2003; Nuissl & Rink, 2005; Yin et al., 2011). Last, marketization allows local factors such as accessibility play a more important role beyond state plans. Reforms promoted the specialized division of labor across regions based on market transaction and comparative advantages such as land resource. Driven by rapid industrialization, China's market-oriented reform results in more efficient land use.

Globalization, urban expansion and land use change

Since the 1970s, economic and social development, and technological innovations have been profoundly affected by the globalization process in almost all big cities around the world. Rapid land use changes have often coincided with the incorporation of a region into an expanding world economy (Lambin & Geist, 2001). As Lambin and Meyfroidt (2011) note, over the past 30 years the world economy has experienced an increasing separation between the location of production and consumption. Globalization increases the worldwide interconnectedness of places and people through markets, information and capital flows, human migrations, and social and political institutions (Porter, 2000). Consequently, different countries' economies have been able to seek resources, capital, technology and a market worldwide. Developing countries participated in the global competition with their cheaper labor and relatively abundant resources. Thus, the process of globalization significantly changes patterns of land use and any other resources in developing countries.

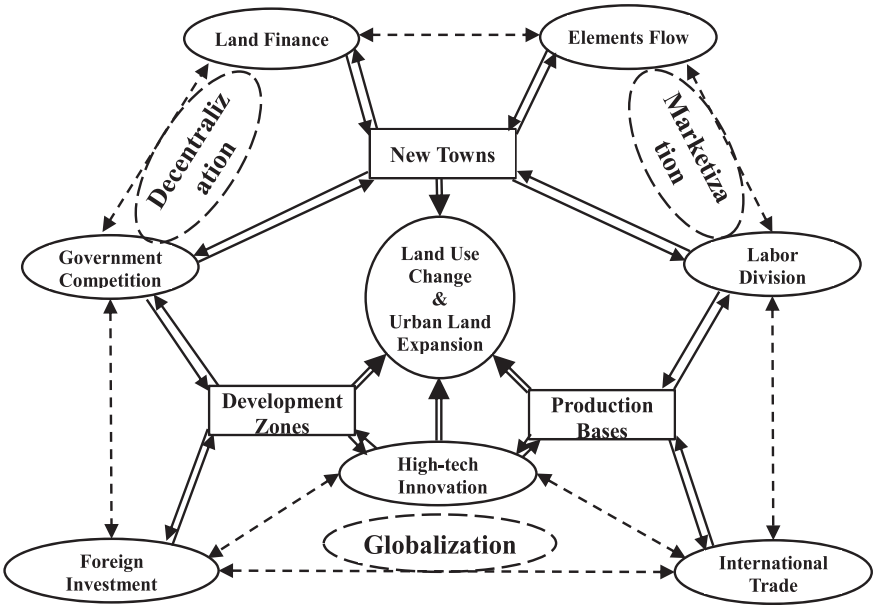

Fig. 2. Conceptual framework for analyzing land use change and urban land expansion.

With various social institutions increasingly making closer contact with market mechanisms, globalization has become the main determinant of land use change in China (Lambin & Geist, 2001). Specifically, China's participation in the globalization process has involved its integration into the global economy by attracting foreign investment, participating in international trade, and promoting technological progress (Breslin, 2000). At the same time, FDI clustering in Chinese cities has made development zones "hot spots" of urban land development, and cities, especially coastal cities, globalizing cities and even emerging global cities (Timberlake, Wei, Ma, & Hao, 2014), although substantial differences can still be observed among coastal cities (Yuan, Wei, & Chen, 2014) and foreign firms have had weak linkages with domestic firms (Liao & Wei, 2013; Wei & Liao, 2013).

On the other hand, trade liberalization has accelerated the process of market integration, strengthened regional comparative advantage, and essentially made China a world factory. Moreover, it has also been argued that structural adjustment of the international market and trade might also affect China's domestic production and thus induce a change in regional land use patterns and structure by replacing or rearranging the local factors determining land uses. Technological innovation has also been seen potentially to alter the slope of the bid-rent curve by reducing production costs, increasing the effective market supply of land, promoting intensive land use, or improving output efficiency, all of which would ultimately accelerate regional land use change (Fischer & Schrattenholzer, 2001; Rounsevell, Ewert, Reginster, Leemans, & Carter, 2005).

Decentralization, urban expansion and land use change

After the establishment of socialism in 1949, China formulated a centralized system of finance, investment, and administration in order to take control over the economy and to launch the Soviet model of industrialization, in which the central government controlled revenue and resources allocation, while local states were assigned the task of agents of the central state, and had very limited power in controlling local economies (Wei, 2001). This consequently cut off the local contact between financial revenue and expenditure and led to low enthusiasm to develop the local economy and increase fiscal revenues (He, Wei, & Xie, 2008). China's economic reform prompted decentralization of central government, responsibilities to local governments, which have taken the primary responsibility for economic development in their own jurisdictions (Qian & Weingast, 1997). Particularly, the tax reform in 1994 increased revenue sharing and decentralized fiscal responsibilities to local governments, which stimulated local governments to develop local economies and seek more budget, or extra-budget revenues. Under decentralization, there are powerful economic incentives for local officials to increase their revenue by obtaining rural land to expand their developed areas (Yang & Li, 2014). Also driven by the powerful fiscal incentives and political promotion opportunities, local officials leased most of the land for manufacturing purposes at low prices, partly because of the importance of the manufacturing sector in generating local GDP and employment. What's more, the local urban land supply is another key to extract maximum extra-budgetary revenue (Bai et al., 2014). Therefore the land finance and political tournaments among local governmental officials become the main incentives of urban expansion and land use change. This means that "the vertical competition between the father and sons" and "the horizontal competition between brothers" constitutes the unique mechanism of China's land use change during the transition era.

Data and methodology

Data

Today, there are three kinds of land use data available in China. One is drawn from the statistical yearbook, which provides only the total area and the area of arable land; another is from remote sensing imagery, which is very different from the statistical data so they cannot be compared with each other; and the last is drawn from the land administration department, which contains information on all types of land use in different areas across China, and is updated yearly. The statistical process involved in the third data type is very similar to the process of socio-economic data extraction provided by the statistics department. Thus the third kind of data has been widely used in various kinds of socio-economic analysis (Lin & Ho, 2003). For this reason, we chose to use the third kind data from a detailed investigation and updated survey on a county level in this paper. It should be noted that, as land use data became state classified information after the second national land use investigation in 2009, we were only able to access data from 1996 to 2008. We also collected other data about labor, capital, industry, FDI, and so forth, for the periods of 1996–2001 and 2002–2008 from the Jiangsu Statistical Yearbooks and the Jiangsu Finance Yearbooks.

Methodology

Land use change is commonly measured in two ways: (1) the land use change rate for a single land use type, which is a measure of a particular major regional change in land use types; it can be used to reflect the direction of regional land use change in the future; (2) the comprehensive land use change rate, which can be used to reflect the transfer rate between different land use types within the study period. It also can be used to identify the hot spots of land use change around the study area. Following Li et al. (2009), these two rates can be calculated as follows:

$$K = \frac{U_b - U_a}{U_a} \Big/ T \times 100\% \tag{1}$$

$$LC = \frac{\sum_{i=1}^{n} \Delta LU_{i\to j}}{2 \times \sum_{i=1}^{n} LU_i} \Big/ T \times 100\% \tag{2}$$

Here, K and LC represent the land use change rate for a single land use type (percent) and comprehensive land use change rate (per cent); U_a and U_b are the areas of the land use type at the beginning and end of a period; LU_i is the area of the ith land use type at the beginning; $\Delta LU_{i\to j}$ is the area of type i converted to type j. T is time intervals (years); n is the total number of land use types.

Empirical models and variable specifications

Focusing on the impact of China's economic transition on land use changes, we built the following conceptual model to explore the relevant factors of land use change in Jiangsu province.

$$K_{it} = F(M_{it}, G_{it}, D_{it}, Region_i) \tag{3}$$

Here, i means the ith county; t is the study period; M, G, D are the variables, representing marketization, globalization, and decentralization. Local factors, such as accessibility and local socio-economic situation, may play important roles. Wu, Cao, Cao, and Liang (2009) have found that counties in Sunan (southern Jiangsu) were superior to the northern ones in all three indices, namely the integrated transportation accessibility, passenger and

freight scale, and the comprehensive transportation cost. Coincidentally, Wei and Fan (2000) suggested that the coalescence of state policy, local agents, and foreign investment had widened the historical gap between northern and southern Jiangsu, and was likely to accelerate inter-county inequality in the future. So we used a dummy variable of *Region* (1 means south of the Yangtze River, 0 means the north) to describe differences of local factors (e.g. transportation superiority and level of regional development) (Table 1).

In terms of the variables, the process of marketization affects the flow of elements and raises labor productivity (Bai, Du, Tao, & Tong, 2004). With economic development, both the decrease in arable land and the expansion of construction land are closely related to the flow of labor and the active capital market (Lichtenberg & Ding, 2008). In addition, industrial productivity might attract external elements and improved local production conditions by way of regional specialization, which can then affect the pattern and structure of local land use. In light of this, we took the variables of labor mobility (*LM*), capital activity (*CA*), and the average industrial added value rate (*IR*) to measure the marketization difference between all the counties. The formulas are as follows:

Table 1
The definitions/calculate methods of variables.

Variables	Symbols	Definitions/calculate methods
Single land use change rate	*K*	A measurement of a particular major regional change in a single land use type. It can be calculated by the average changed areas of one land use type in a particular time intervals.
Labor mobility	*LM*	A measurement of the flow of labors. It can be calculated by the yearly change of employed persons in different industries, namely the agriculture, industry, and services sectors, during a particular time intervals.
Capital activity	*CA*	A measurement of the flow of the capitals. It can be calculated by the average proportion of the loans accounted to the total number of loans and deposits in a particular time intervals.
Industrial added value rate	*IR*	A measurement of the industrial productivity. It can be calculated by the average proportion of the industrial added value accounted to the total number of gross industrial output value and taxes and profits in a particular time intervals.
Strength of foreign direct investment	*FDI*	A measurement of the strength of FDI. It can be calculated by the relative proportion of the absolute values of FDI account to the GDP in a particular time intervals.
Strength of international trade	*IT*	A measurement of the improvement of the international trade. It can be calculated by the sum of the yearly change rate of the total numbers of both the imports and the exports.
Level of technological innovation	*TI*	A measurement of the importance of the technological innovation. It can be calculated by the proportion of the scientific and technical personnel to all the staff and workers in a particular time intervals.
Weighted government competitiveness	*GC*	A measurement of the power of local governments. It can be calculated by the average economic development (per capita GDP corrected by the consumer price index), which is weighted by the administrative level (county-level city = 1.2, county = 1, municipal district = 0.8).
Local land finance demand	*LF*	A measurement of the motivate force of the "Land Revenue". It can be calculated by the proportion of tax revenue that accounts for the general budget expenditure.
Regional location	*Region*	It is a dummy variable, which is used to describe differences of local factors, such as accessibility (e.g. distance to Shanghai) and level of regional development. 1 means south of the Yangtze River and 0 means the north.

$$LM_{it} = \sum_{j=1}^{3}\left(\left|W_{ijt_1} - W_{ijt_0}\right| / W_{ijt_0}\right) \times 100\% \tag{4}$$

$$CA_{it} = \frac{1}{t_1 - t_0}\sum\nolimits_{t=t_0}^{t_1} L_{it}/(L_{it} + D_{it}) \times 100\% \tag{5}$$

$$IR_{it} = \frac{1}{t_1 - t_0}\sum_{t=t_0}^{t_1} I_{it}/(P_{it} + T_{it}) \times 100\% \tag{6}$$

Here, *W*, *L*, *D*, *I*, *P*, *T* represent the numbers of employed persons (year-end), loan balances of banks (year-end), deposits balances of banks (year-end), industrial added value, gross industrial output value, total taxes and profits respectively; *j* means the agriculture, industry, and services sector; t_0 and t_1 signify the beginning and the end of the study period.

In terms of globalization, foreign investment, international trade and technological innovations have affected the structure of regional land use. Thus we tested the influence of economic globalization on regional land use change by measuring the strength of regional foreign investment (*FDI*), international trade (*IT*) and the level of technological innovation (*TI*). The equations are as follows:

$$FDI_{it} = \frac{1}{t_1 - t_0}\sum\nolimits_{t=t_0}^{t_1} fdi_{it}/GDP_{it} \times 100\% \tag{7}$$

$$IT_{it} = \left[\left(Exp_{it_1} - Exp_{it_0}\right)/Exp_{it_0} + \left(Imp_{it_1} - Imp_{it_0}/Imp_{it_0}\right)\right] \times 100\% \tag{8}$$

$$TI_{it} = \frac{1}{t_1 - t_0}\sum\nolimits_{t=t_0}^{t_1} Pro_{it}/Emp_{it} \times 100\% \tag{9}$$

Here, *fdi*, *GDP*, *Exp*, *Imp*, *Pro*, *Emp* refer to foreign capital actually used, gross domestic product, total exports, total imports, number of scientific and technical personnel, and number of staff and workers respectively.

Decentralization is one of the most important transition processes in China. This process affects changes in regional land use by way of local government competition and local demands for land finance. First, we suggest that more powerful local governments are able to obtain a greater quota of construction land and have a greater chance to modify the land use plans. And the competitiveness of local governments depends on their administrative level and economic development (e.g. the per capita GDP). Usually, county-level cities have the highest level; municipal districts have the lowest. Thus, we defined the variable of weighted government competitiveness (*GC*) to reflect the importance of the competitiveness of local government in impacting on regional land use change. The equation is as follows:

$$GC_{it} = \frac{1}{t_1 - t_0}\sum\nolimits_{t=t_0}^{t_1} cpi_t \cdot gdp_{it} \times G_i \tag{10}$$

Here, *gdp* is per capita GDP (at current price); *cpi* is the consumer price index used to correct *gdp* to the comparable price; *G* is

the weighted score (county-level city = 1.2, county = 1, municipal district = 0.8).

Second, larger land revenue reflects a greater motivation to change land use patterns. Many local governments began to seek the extra-budgetary income. As an important source of wealth, land revenue became the "second fund" of local government. However, as it proved difficult to collect the land finance data, we had to choose another index to replace this. We therefore calculated land finance demand (*LF*) to characterize the land finance associated with regional land use change; the formula is as follows:

$$LF_{it} = \left(1 - \frac{1}{t_1 - t_0}\sum_{t=t_0}^{t_1} Tax_{it}/F_{it}\right) \times 100\% \quad (11)$$

Tax is the tax revenue (part of the general budgetary revenue); *F* is the general budgetary expenditure. The greater the proportion of tax revenue that accounts for the general budget expenditure, the smaller the demand for land finance. Land use change is associated with socio-economic system changes. The relative rank of land use change rate is more or less stable. We therefore employed a rank regression model to control for the impact of different data dimensions. The model is framed as follows:

$$R(K_{it}) = \beta_0 + \sum_{k=1}^{9} \beta_k R(X_{itk}) + u_i + \varepsilon_t \quad (12)$$

R is the rank conversion function; βs are the coefficients to be estimated; *u* is the individual error component specific to each county and ε is the idiosyncratic error that is assumed to be independent of both the regressors and the individual error component.

Spatio-temporal patterns of land use change and urban expansion

Land use changes in Jiangsu are characterized by the decrease in arable land and orchard land, the expansion of construction land, and increase of unutilized water areas, like other provinces of China (Liu et al., 2010). Taking county level cities, counties, and municipal districts as the basic units of analysis, we found that during the period of 1996–2008, construction land increased by 3375.7 km^2, while arable land and water area declined by 2295.2 km^2 and 1481.1 km^2 respectively, and orchard land increased by 24.7 km^2 (Table 2). In 1996–2001, construction land expanded by 6.02% while arable land and orchard land decreased by 1.17% and 6.54% respectively. This was followed in the next six years by a sharp increase of construction land by 14.26% and a continue reduction of arable land by 3.45%.

Spatial characteristics of land use change in Jiangsu province over different periods of time (1996–2001 and 2002–2008) are highlighted in Figs. 3 and 4. The land use change in Jiangsu from 1996 to 2001 is as follows: (1) the arable land decreased rapidly in Sunan with the high level of industrialization. Some suburban counties in Subei witnessed a slight increase in arable land, with a significant increase in arable land close to the coast and a great deal of land reclamation. (2) The orchard land decreased mainly in the orchard-dense areas of Suzhong and Subei, keeping a constant arable land scale. (3) The water area decreased slightly in counties close to the coast and along canals; while some agricultural counties in Suzhong experienced an increase in water area. (4) Similar to the spatial distribution of arable land decrease, the expansion of construction land mainly occurred in Sunan and some developed counties of Suzhong, while the scale of construction land in some coastal counties of Subei appeared to reduce slightly.

Fig. 4 demonstrates the following characteristics of land use change in Jiangsu from 2002 to 2008: (1) the continued decline of arable land in Sunan increased the pressure on the arable land supplement in Subei. (2) There was an increase in orchard land in part of the Yixing-Liyang hill area, Maoshan downs, and Lixiahe lowland. (3) With the reclamation of both the coastal and the inland wetlands, the water area all over the province reduced significantly, except in the hill area in Sunan and the slope and lowland in Subei. (4) Every county experienced a rapid expansion of construction land except Ganyu and Binhai County. Similar to the previous stage, most of the construction land still concentrated in Sunan, in particular the Taihu Basin and Nanjing Proper, which is consistent with the finding at the national level that economic development, urban expansion and even industrial pollution are largely concentrated in the national and regional cores of China (e.g., He, Huang, & Ye, 2014; Wei & Ye, 2014; Yue et al., 2014)

Land use restructuring: spatial auto-correlation analysis

We calculated the land use change rate for arable land, orchard land, water area and construction land, and analyzed the spatial autocorrelation of the land use change rate with the Moran's *I* index. The Moran's *I* statistic for spatial autocorrelation is given as:

$$I = n\sum_{i=1}^{n}\sum_{j=1}^{n} wijZ_i^a Z_j^b \Big/ (n-1)\sum_{i=1}^{n}\sum_{j=1}^{n} wij \quad (13)$$

Here, Z_i is the deviation of an attribute for county *i* from its mean $(X_i - \overline{X})$, w_{ij} is the spatial weight between feature *i* and *j*, *a* and *b* mean change rates of different land use types, *n* is equal to the total number of features. The value of *I* represents the global spatial association of change rates of two land use types, and the greater the absolute value means the stronger spatial association. And the positive value indicates positive spatial association; negative ones represent negative spatial association.

As illustrated in Table 3, the reduction of arable land and construction land expansion had the highest Moran's *I* index, which indicated the spatial agglomeration of the two main types of land use change. And the fact that there exists a negative correlation between the change rate of arable land and the change rates of orchard land or water area could be interpreted as the arable land supplement, due to the reduction of orchard land and water area in Jiangsu. By contrast, changes in the use of construction land could better explain the arable land change and comprehensive land use change, which can be interpreted as the construction land expansion leading to the decrease in arable land, and dominating the regional land use change. This spatial autocorrelation was gradually strengthened through the process of economic transition. Thus we can conclude that the dominant land use changes in Jiangsu are the decrease in arable land and the expansion of construction land.

Table 2
Land use change and urban land expansion in Jiangsu, 1996–2008.

Land use type	1996 (km^2)	2001 (km^2)	Change (%)	2002 (km^2)	2008 (km^2)	Change (%)	Total change (km^2)
Arable	50,617	50,025	−1.17	49,341	47,638	−3.45	−2979
Orchard	3137	2932	−6.54	2870	3162	10.18	25
Water	32,262	32,333	0.22	32,309	30,757	−4.81	−1505
Construction	15,741	16,688	6.02	17,035	19,464	14.26	3723

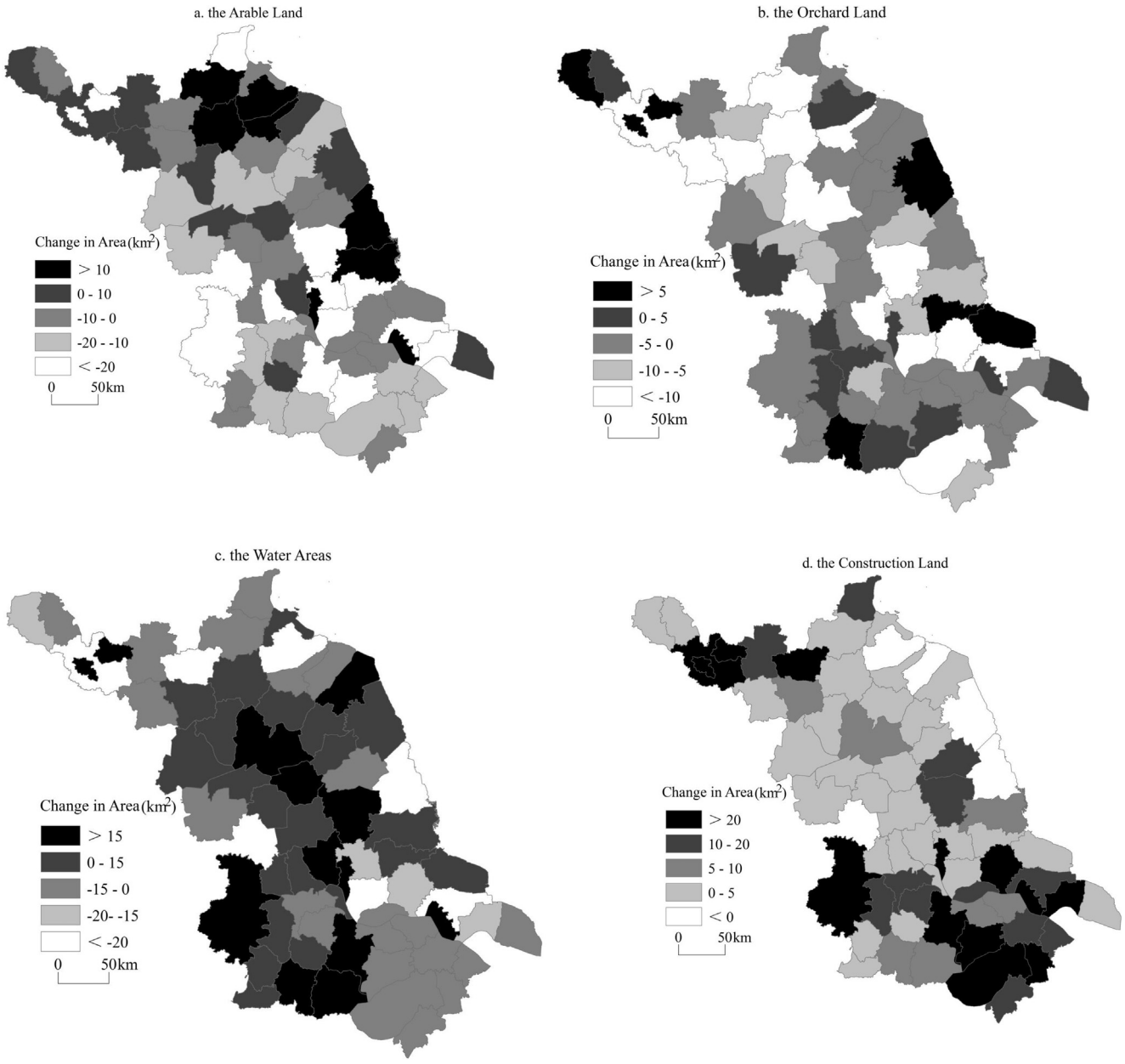

Fig. 3. Major types of land use change in Jiangsu, 1996–2001.

As the decrease of arable land and the construction land expansion reflect the most significant features of land use change in Jiangsu, there is also a significant linear relationship between these two types of land use change judging from the OLS models, which take the rank of arable land change as the *X* axis and the rank of the construction land change as Y; the higher rank means the relatively more increase in construction land or less reduction in arable land. Fig. 5 demonstrates a significant linear relationship between the changes of arable land and construction land in 1996–2001, which highlights once more that the loss of valuable arable land was mainly caused by the encroachment of urban development, especially massive construction sites from land speculation. This phenomenon has also been discussed in the Pearl River Delta (PRD) by Yeh and Li (1999). In the period of 2002–2008, both construction land expanded and arable land reduced at a high rate in some developed counties (zone A). As to the critical point E, change rates of both arable and construction land are the lowest. Policy aiming to preserve arable land has also resulted in reclamation of the arable land supplement in those coastal counties in Subei (zone B). The relationship between the reduction of arable land and the increase of construction land shows a significant U-shape, as is shown in Fig. 6. The large-scale expansion of construction land has resulted in both the massive loss of arable land in the developed counties in Sunan and the reclamation of arable land in other counties, especially the northern and coastal counties.

In summary, land use in Jiangsu has changed dramatically under economic transition. Moreover, it is evident that Jiangsu's land use change was dominated by the expansion of construction land, particularly Sunan and municipal districts.

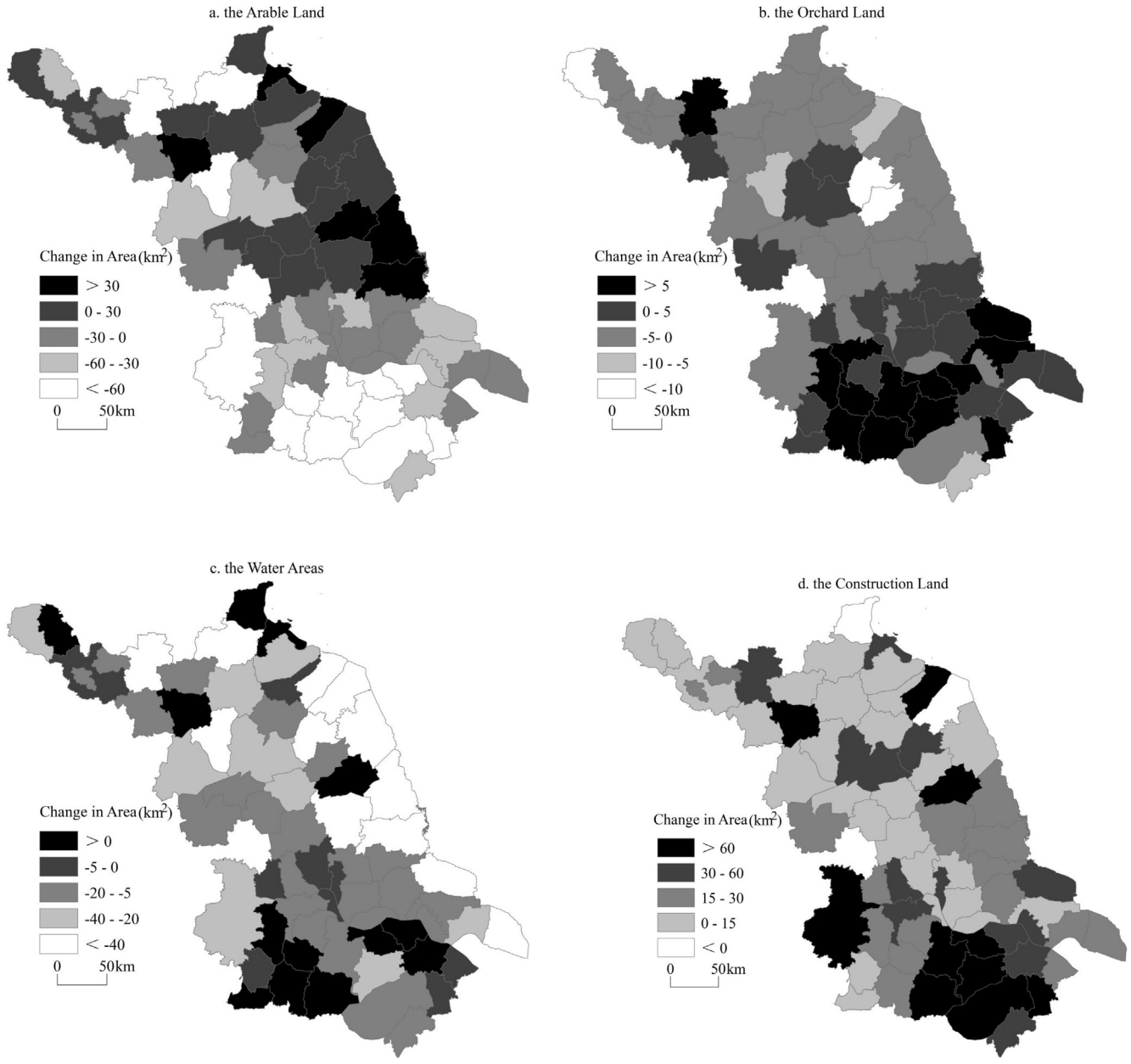

Fig. 4. Major types of land use change in Jiangsu, 2002–2008.

Mechanism of land use change and urban expansion: regression analysis

The proceeding analysis employs change rates in construction land as a dependent variable and model driving mechanism of land use change at a county level during the transition era. From the descriptive statistics (Table 4), we find that with the process of economic transition the average growth rate of construction land became larger but the maximum rate slowed down, which resulted to a smaller standard deviation. While capital (*CA*) and FDI spread across Jiangsu, the gap in industrial productivity (*IR*) even increased and labor (*LM*) further concentrated in Sunan. Also the gaps in

Table 3
Moran's *I* index of land use change.

Land use change	1996–2001					2002–2008				
	Arable	Orchard	Water	Construction	Overall	Arable	Orchard	Water	Construction	Overall
Arable	0.16	−0.14	−0.07	−0.20	−0.08	0.58	−0.38	−0.30	−0.49	−0.23
Orchard	−0.17	0.01	−0.00	0.08	0.01	−0.42	0.24	0.13	0.38	0.17
Water	−0.53	−0.09	−0.15	−0.34	−0.10	−0.32	0.15	0.12	0.17	0.08
Construction	−0.17	0.12	−0.15	0.16	0.03	−0.45	0.32	0.13	0.33	0.19
Overall	−0.09	0.05	−0.08	0.15	0.07	−0.24	0.18	0.09	0.27	0.20

Note: the column are the 1st variables (also the spatial lag variables), the row are the 2nd variables (also the non-spatial lag variables).

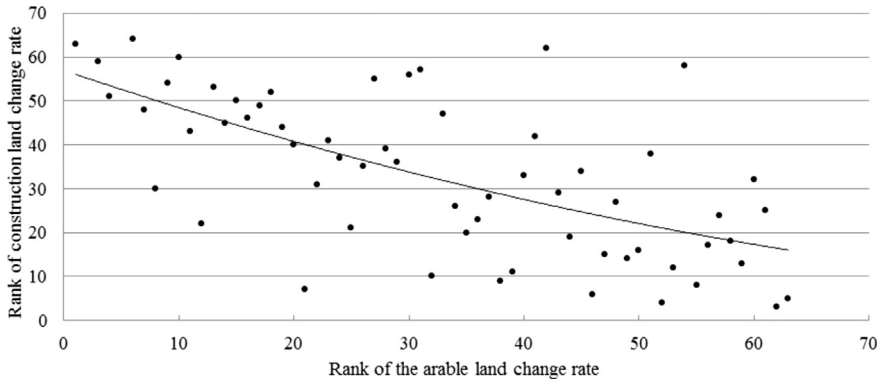

Fig. 5. The relationship between arable land and construction land change, 1996–2001.

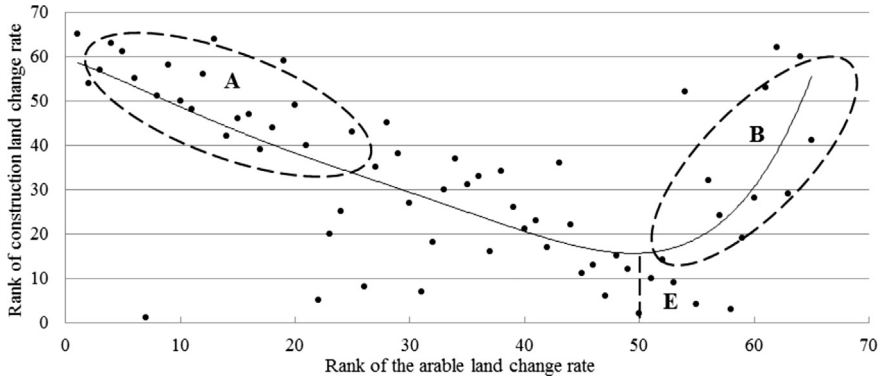

Fig. 6. The relationship between arable land and construction land change, 2002–2008.

international trade (*IT*) and technology innovation (*TI*) become larger. Coincidentally the government competitiveness (*GC*) and financial dependence on land (*LF*) played a more important role in local land development with decentralizing of the fiscal responsibilities.

As is shown in Table 5, four models in the two periods are derived to analyze the impact of marketization, globalization and decentralization on changes in construction land in Jiangsu. In order to address multicollinearity between *IT*, *GC* and *LF*, all variables except *IT* and GC in 1996–2001 and *IT* and *LF* in 2002–2008 were introduced to Model 4. The regression results indicated that marketization, globalization and decentralization in Jiangsu could adequately explain the regional land use change during the economic transition era.

Models focusing on the land use change in 1996–2001 reveal that the land use change in Jiangsu was firstly driven by local governments in the early stages of economic transition. A stronger government might have more advantages when competing with others for preferential policies and foreign investments. Moreover, industrial development and urban construction in these counties was so rapid that changes in the land use also occurred faster. As Zhu (2004) noted, those governments having economic and technology development zones (ETDZs) in the jurisdiction were much more competitive than other governments in attracting foreign investment that most development zones became the focus of industrial development and urban expansion in Jiangsu. Herrmann-Pillath and Feng (2004) also studied in Zhangjiagang that competitive governments had more opportunities in bargaining with higher level or even central government in China. Models investigating land use change in 2002–2008 indicate that China's entrance to the WTO has accelerated the process of globalization and land use change in Jiangsu. In addition, the market-oriented

Table 4
The descriptive statistics of dependent and independent variables.

Variables	1996–2001				2002–2008			
	Min	Mean	Max	Std. dev.	Min	Mean	Max	Std. dev.
K-Construction	−13.59	8.95	216.56	27.86	−16.09	14.44	88.60	16.47
LM	4.19	28.08	133.37	19.04	46.26	181.53	451.81	86.21
CA	31.13	43.51	56.54	6.07	28.03	37.18	47.25	4.65
IR	21.10	32.75	58.49	7.63	22.81	37.48	74.54	11.98
FDI	0.30	4.28	29.25	5.75	0.43	4.93	19.20	3.61
IT	0.09	18.26	143.36	29.30	0.85	35.88	428.44	70.21
TI	17.38	34.22	50.22	7.24	23.24	48.95	103.19	15.28
GC	669	2660	8801	2079	1090	5483	30,307	5368
LF	−6.17	31.49	67.82	19.31	−4.88	39.39	73.02	21.33
Region	0.00	0.29	1.00	0.45	0.00	0.29	1.00	0.45

Table 5
Regression result of economic transition and land use change.

Variables	1996–2001				2002–2008			
	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
Constant	28.08*** (3.48)	18.63*** (3.27)	13.47 (0.75)	31.40** (2.50)	31.08*** (5.72)	12.50*** (3.16)	51.89** (2.09)	9.19 (1.05)
LM	0.07 (0.63)			0.09 (0.64)	0.04 (0.47)			0.05 (0.65)
CA	−0.16 (−1.29)			0.05 (0.31)	0.34*** (3.64)			0.38*** (4.00)
IR	0.19* (1.77)			0.13 (1.09)	−0.42*** (−4.45)			−0.23** (−2.13)
FDI		0.01 (0.06)		0.03 (0.50)		0.21 (1.06)		0.16* (1.92)
IT		0.28* (1.59)				0.78*** (5.02)		
TI		0.06 (0.50)		0.07 (0.54)		−0.44* (−1.85)		0.10 (1.03)
GC			0.48* (1.62)				−0.04 (−0.11)	0.24* (1.97)
LF			0.07 (0.23)	−0.28 (−1.42)			0.35** (2.40)	
Region	15.87*** (3.11)	9.21* (1.52)	4.79 (0.76)	9.17* (1.42)	10.80** (2.58)	10.33** (2.49)	8.46* (1.53)	3.84** (1.69)
D-Watson	1.98	1.76	1.74	2.00	2.07	2.20	2.19	2.25
Adjust R^2	0.45	0.48	0.51	0.54	0.57	0.60	0.51	0.64

Note: ***significant at 0.01 level; **significant at 0.05 level; *significant at 0.1 level; numbers in parentheses are the *t* statistics; sample size is 65.

reform accelerated the flow of elements and improved the efficiency of land allocation. Both of the latter processes then led to rapid regional land use change, as characterized by the expansion in construction land in Jiangsu. In contrast, government forces became gradually weaker with the significant regression coefficient of 0.48 turning to the non-significant one. But the financial dependence on land played a significant role in this period.

From the perspective of marketization, labor flow was one of the major factors driving for urban growth and thus accelerating the rate of land use change in outskirts of the urban areas. However, variables about the influence of rural to urban migration yielded a non-significant regression coefficient, which can be well interpreted by China's special household registration system. As one of the main factors of marketization, capital activity also promoted land use change in Jiangsu in 2002–2008. But in the period of 1996–2001, more than 67% loans were mainly used for short-term basic business operations (*e.g.* wages, raw material procurement, *etc.*) rather than construction (Table 6).

With the market-oriented reform, in particular the liberalization of land markets, market demand plays a positive role in the process of regional land use change. This suggests that improving production efficiency may promote specialization and centralization, and, in turn, accelerate changes in regional land use. The variable of *IR* had a significantly positive regression coefficient in the period of 1996–2001, which indicates that the improvement of industrial production efficiency depended largely on land factor inputs in the early stage of economic transition. Table 7 shows that, after the entry into the WTO, ways to improve the industrial productivity no longer largely relied on increasing the input of production elements. Higher production efficiency uses less land input, which was the reason why the regression coefficient of *IR* turned to be negative in 2002–2008.

Globalization had a profound impact on land use changes, especially after China's entry to the WTO. Since 2001, cities in Jiangsu, in particular those in Sunan, have been pushing hard for globalization and growth, reflected in the concern over potential marginalization by Shanghai, China's emerging global city (Wei & Li, 2002). FDI in Jiangsu increased from $4.78 billion in 1995 to $7.12 billion in 2001, and soared to $2.5 billion in 2008, with the total import and export value increasing from $18.01 billion in 1995 to $54.48 billion in 2001 and $430.48 billion in 2008 respectively (JSB, 2009). All these globalization processes contributed to economic and population growth that have stimulated rapid urban sprawl and land use change in Jiangsu. Indeed, scholars have also long argued that technological innovation has the potential to replace labor and capital inputs when reaching a certain stage of development. In metropolitan China, higher productivity is due to its greater industrial mix, more specialized services, higher quality of labor force, better urban infrastructure, and improved access to international markets (Wei & Li, 2002). Thus in the first five years the proportion of scientific and technical personnel to total workers had a positive but insignificant regression coefficient. With the improvement of labor productivity, technological innovation rather than labor and capital inputs became the key of economic growth (Tables 7 and 8). Thus land use change rates were smaller in counties with more skilled workers during 2002–2008.

After the tax-sharing reform in 1994, local governments faced increased pressure associated with economic development given the imbalance between local affair and fiscal rights. Local governments, therefore, began to seek development incentives from limited land resources, which accelerated the regional land use change to some extent. On the one hand, local governments get extra budgetary revenue in the form of land granting; on the other hand, they get budgetary revenue in the form of land tax through land investment. Consequently, land-based finance, in particular the land granting strategy, became crucial to local budgetary balance. Since 2002, more than half of the local government budgetary expenditure (LGBE) was from the land revenue (Table 9). But such a pattern of development characterized by over-dependence on land finance caused rapid urban expansion and serious social conflicts (Bai et al., 2014).

Table 6
Structure of loans balance by year end in Jiangsu, 1996–2008.

Year	1996	1997	1998	1999	2000	2001	1996–2001
Total loans by year end (billion yuan)	274	365	427	554	597	667	2882
Short-term loans (%)	76.4	82.8	81.4	77.8	76.4	69.2	76.5
Medium-term & long-term loans (%)	23.6	17.2	18.6	22.2	23.6	30.8	23.5
Year	2002	2003	2004	2005	2006	2007	2008	2002–2008
Total loans by year end (billion yuan)	824	1130	1348	1540	1840	2209	2616	11,515
Short-term loans (%)	65.4	60.8	54.4	50.7	50.2	50.0	46.8	52.1
Medium-term & long-term loans (%)	34.6	39.2	45.6	49.3	49.8	50.0	53.2	47.9

Source: compiled from JSB (1997–2009).

Table 7
Marginal consumption of construction land (MCCL) in 1996–2008.

Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
IAV (billion yuan)	276	302	316	339	385	427	488.0	601	751	944	1110	1311	1527
IAVR (%)	20.5	20.5	20.8	21.5	21.8	21.8	22.8	23.2	23.4	24.4	23.4	22.1	22.0
STIAV (billion yuan)	502	565	615	666	751	836	950	1128	1364	1714	2020	2420	2888
CLA (km^2)	15,842	16,283	16,383	16,502	16,605	16,855	17,136	17,444	18,073.31	18,315	18,691.22	19,024	19,341
CCL (km^2/billion yuan)	31.6	28.9	26.6	24.8	22.1	20.2	18.0	15.5	13.3	10.7	9.3	7.9	6.7
MCCL		22.1	6.9	8.8	4.9	13.2	12.3	9.6	17.3	5.2	11.5	9.0	8.6

Note: IAV = industrial added value; IAVR = industrial added value rate; STIAV = secondary & tertiary industry added value; CLA = construction land area; CCL = consumption of construction land per unit of secondary & tertiary industry added value; MCCL = marginal consumption of construction land per unit of secondary & tertiary industry added value, means the scale of construction land occupied with each 1% growth in secondary & tertiary industry added value.
Source: compiled from JSB (1997–2009), and detailed investigation and updated survey data drawn from the land administration department.

Table 8
Stage of development and labor productivity in 1996–2008.

Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
PGDP (yuan)	8471	9371	10,049	10,695	11,765	12,882	14,396	16,830	20,223	24,560	28,814	33,928	39,622
STEP (million)	2.37	2.41	2.44	2.48	2.53	2.62	2.72	2.86	2.98	3.09	3.22	3.34	3.43
PST (yuan)	21,134	23,448	25,181	26,834	29,698	31,910	34,864	39,443	45,814	55,470	62,759	72,385	84,296

Note: PGDP = per capital gross domestic product; STEP = employed person of secondary & tertiary industry; PST = per capita productivity of secondary & tertiary industry.
Source: compiled from JSB (1997–2009).

At the same time, the regional imbalanced development issue attracted much governmental and scholarly attention, and arable land decreased in the developed areas. Policy makers began to realize that local governments were unequal in using land resource; counties in Sunan are so much more competitive so that they can find new ways to develop rural land. It was not until 2001 when the provincial government of Jiangsu promoted a new model of integrated development in Jiangsu (Luo & Shen, 2009). Capital and industrial activity are encouraged to relocate to Subei and some other less developed counties in Suzhong (e.g. Suzhou-Suqian Industrial Park, Jiangyin Development Zone in Jingjiang, Kunshan-Shuyang Industrial Park, Jiangning Economic and Technological Development Zone in Jingjiang, etc.). As a result, the coefficient of *GC* became smaller or even negative in 2002–2008. Moreover, the process of marketization and globalization, facilitated by decentralization and government competition, becomes a key driver of land use change in Jiangsu.

Conclusion

Economic transition in China has significantly influenced changes in the country's regional land use patterns. This process can also be conceptualized into a triple process of marketization, decentralization and globalization. Marketization changes the land use structure by accelerating the elements flow and geographical division of labor. Relaxed state control over the rural economy and rural to urban migration has promoted the conversion of land from agriculture to non-agriculture, and from rural to urban sectors.

Globalization has triggered China's industrial agglomeration and specialization by attracting a significant amount of FDI, promoting trade liberalization and technological innovation. It has also accelerated changes in the country's regional land use. The increase of FDI and the structural adjustment of the international market and trade stimulated the construction enthusiasm of China's development zones, affected domestic production and, ultimately, contributing to a shift in regional land use patterns and structure by replacing or rearranging local factors of land use change. In addition, the technological innovation mostly brought by multinational corporations accelerated regional land use change. Decentralization changed the regional land use structure through the vertical fiscal competition and horizontal promotion competition between neighboring local governments.

Using rank regression models, this paper investigated the macro driving forces of land use change in Jiangsu during the transition era of 1996–2008. Our results showed that, since the mid-1990s, the expansion in construction land has led to a substantial loss of arable land all over the province. The growing pressure to maintain a constant arable land scale led to a rapid reduction of the water area in Subei and the coastal region. A finer scale regression analysis unfolds driving mechanisms of land use change at a county level during the transition era, drawing upon a conceptual process of economic transition. We have found that marketization, globalization and decentralization in Jiangsu could explain these changes in regional land use during the economic transition era.

In the early stages of the development of the market economy, local government dominated regional land use change. The influence of marketization factors, such as efficiency in industrial production and labor flow, was more important, followed by the technological innovation factor. The influence of globalization factors such as FDI and the import and export of traded goods began to play a much more important role only after China's entry into the WTO. The influence of the efficiency in industrial production and labor weakened with improvements in economic development.

Table 9
Land revenue and its proportion in local government budgetary expenditure in Jiangsu.

Year	1999	2000	2001	2002	2003
Land financial revenue (billion yuan)	6.62	11.43	24.98	51.02	104.35
Land granting revenue (billion yuan)	4.42	8.18	21.61	45.46	95.93
% of Land financial revenue in LGBE	13.66	19.33	34.23	59.30	99.60
% of Land granting revenue in LGBE	9.12	13.83	29.61	52.84	91.56
Year	2004	2005	2006	2007	2008
Land financial revenue (billion yuan)	79.48	117.00	141.07	183.79	174.44
Land granting revenue (billion yuan)	67.45	100.73	119.71	150.23	131.86
% of Land financial revenue in LGBE	60.58	69.91	70.07	71.97	53.72
% of Land granting revenue in LGBE	51.41	60.19	59.46	58.83	40.61

Source: compiled from MLR (2000–2009).

Our results also indicate that technological innovation slowed down the rate of regional land use change. Finally, the demand for land revenue is playing an increasingly significant role in the ways in which local governments negotiate changes in land use.

The study has built a ground-specific conceptual framework of land use change based on China's economic transition. More scholarly efforts should be made to undertake further study on this issue. It is promising to apply our framework in case studies of broader geographical scope and other Chinese provinces.

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References

Anderson, G., & Ge, Y. (2004). Do economic reforms accelerate urban growth? The case of China. *Urban Studies, 41*, 2197–2210.
Bai, C., Du, Y., Tao, Z., & Tong, S. (2004). Local protectionism and regional specialization: evidence from China's industries. *Journal of International Economics, 63*, 397–417.
Bai, X., Shi, P., & Liu, Y. (2014). Realizing China's urban dream. *Nature, 509*, 158–160.
Barlowe, R. (1978). *Land resource economics: The economics of real estate* (3rd ed.). New Jersey: Prentice-Hall.
Breslin, S. (2000). Decentralization, globalization and China's partial re-engagement with the global economy. *New Political Economy, 5*, 205–226.
Ding, C., & Lichtenberg, E. (2011). Land and urban economic growth in China. *Journal of Regional Science, 51*, 299–317.
Fischer, G., & Schrattenholzer, L. (2001). Global bioenergy potentials through 2050. *Biomass and Bioenergy, 20*(3), 151–159.
Güneralp, B., Seto, K. C., & Ramachandran, M. (2013). Evidence of urban land teleconnections and impacts on hinterlands. *Current Opinion in Environmental Sustainability, 5*, 445–451.
He, C., Huang, Z., & Ye, X. (2014). Spatial heterogeneity of economic development and industrial pollution in urban China. *Stochastic Environmental Research and Risk Assessment, 28*, 767–781.
He, C., Wei, Y. H. D., & Xie, X. Z. (2008). Globalization, institutional change, and industrial location: economic transition and industrial concentration in China. *Regional Studies, 42*, 923–945.
Herrmann-Pillath, C., & Feng, X. (2004). Competitive governments, fiscal arrangements, and the provision of local public infrastructure in China: a theory-driven study of Gujiao municipality. *China Information, 18*, 373–428.
Jiangsu Statistical Bureau (JSB). (1997–2009). *Statistical yearbook of Jiangsu*. Beijing: China Statistical Press (in Chinese).
Lai, S. K., Ding, C., Tsai, P. C., Lan, I. C., Xue, M., Chiu, C. P., et al. (2008). A game-theoretic approach to urban land development in China. *Environment and Planning B, 35*, 847–862.
Lambin, E. F., & Geist, H. J. (2001). Global land-use and land-cover change: what have we learned so far? *Global Change Newsletter, 46*, 27–30.
Lambin, E. F., & Meyfroidt, P. (2011). Global land use change, economic globalization, and the looming land scarcity. *Proceedings of the National Academy of Sciences of the United States of America, 108*, 3465–3472.
Li, X., Ma, Y., Xu, H., Wang, J., & Zhang, D. (2009). Impact of land use and land cover change on environmental degradation in Lake Qinghai watershed, northeast Qinghai-Tibet Plateau. *Land Degradation & Development, 20*, 69–83.
Liao, H. F., & Wei, Y. H. D. (2013). TNCs' technology linkages with domestic firms: an investigation of the ICT industry in Suzhou, China. *Environment and Planning C, 31*, 460–474.
Liao, H. F., & Wei, Y. H. D. (2014). Modeling determinants of urban growth in Dongguan, China: a spatial logistic approach. *Stochastic Environmental Research and Risk Assessment, 28*, 801–816.
Lichtenberg, E., & Ding, C. (2008). Assessing farmland protection policy in China. *Land Use Policy, 25*, 59–68.
Lin, G. C. S., & Ho, S. P. S. (2003). China's land resources and land-use change: Insights from the 1996 land survey. *Land Use Policy, 20*, 87–107.
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.
Liu, J., Zhan, J., & Deng, X. (2005). Spatio-temporal patterns and driving forces of urban land expansion in China during the economic reform era. *AMBIO: A Journal of the Human Environment, 34*, 450–455.
Liu, J., Zhang, Z., Xu, X., Kuang, W., Zhou, W., Zhang, S., et al. (2010). Spatial patterns and driving forces of land use change in China in the early 21st century. *Journal of Geographical Sciences, 20*, 483–494.
Liu, Y., Yue, W., & Fan, P. (2011). Spatial determinants of urban land conversion in large Chinese cities: a case of Hangzhou. *Environment and Planning B, 38*, 706–725.
Long, H., Zou, J., Pykett, J., & Li, Y. (2011). Analysis of rural transformation development in China since the turn of the new millennium. *Applied Geography, 31*, 1094–1105.
Luo, J., & Wei, Y. H. D. (2009). Modeling spatial variations of urban growth patterns in Chinese cities. *Landscape and Urban Planning, 91*, 51–64.
Luo, X., & Shen, J. (2009). A study on inter-city cooperation in the Yangtze River delta region, China. *Habitat International, 33*, 52–62.
Ma, L. J. C. (2004). Economic reforms, urban spatial restructuring, and planning in China. *Progress in Planning, 61*, 237–260.
Ministry of Land and Resources of China (MLR). (2000–2009). *China statistical yearbook of land and resources*. Beijing: Geological Publishing House (in Chinese).
Munroe, D. K., McSweeney, K., Olson, J. L., & Mansfield, B. (2014). Using economic geography to reinvigorate land-change science. *Geoforum, 52*, 12–21.
Nuissl, H., & Rink, D. (2005). The "production" of urban sprawl in eastern Germany as a phenomenon of post-socialist transformation. *Cities, 22*, 123–134.
Ojima, D. S., Galvin, K. A., & Turner, B. L. (1994). The global impact of land-use change. *BioScience, 44*, 300–304.
Pannell, C. W. (2002). China's continuing urban transition. *Environment and Planning A, 34*, 1571–1590.
Porter, M. E. (2000). Location, competition, and economic development: local clusters in a global economy. *Economic Development Quarterly, 14*, 15–34.
Qian, Y., & Weingast, B. R. (1997). Federalism as a commitment to preserving market incentives. *The Journal of Economic Perspectives, 11*, 83–92.
Rounsevell, M. D. A., Ewert, F., Reginster, I., Leemans, R., & Carter, T. (2005). Future scenarios of European agricultural land use: II. Projecting changes in cropland and grassland. *Agriculture, Ecosystems & Environment, 107*, 117–135.
Rudel, T. K., Coomes, O. T., Moran, E., Achard, F., Angelsen, A., Xu, J., et al. (2005). Forest transitions: towards a global understanding of land use change. *Global Environmental Change, 15*, 23–31.
Shen, J., Feng, Z., & Wong, K. Y. (2006). Dual-track urbanization in a transitional economy: the case of Pearl River Delta in South China. *Habitat International, 30*, 690–705.
Timberlake, M., Wei, Y. H. D., Ma, X., & Hao, J. (2014). Global cities with Chinese characteristics. *Cities, 41*, 162–170.
Turner, B. L., Lambin, E. F., & Reenberg, A. (2007). The emergence of land change science for global environmental change and sustainability. *Proceedings of the National Academy of Sciences of the United States of America, 104*, 20666–20671.
Turner, B. L., Meyer, W. B., & Skole, D. L. (1994). Global land-use/land-cover change: towards an integrated study. *AMBIO: A Journal of the Human Environment, 23*, 91–95.
United Nations. (2001). *World Urbanization Prospects: The 2001 revision*. New York: United Nations.
Verburg, P. H., Van De Steeg, J., Veldkamp, A., & Willemen, L. (2009). From land cover change to land function dynamics: a major challenge to improve land characterization. *Journal of Environmental Management, 90*, 1327–1335.
Wei, Y. H. D. (2001). Decentralization, marketization, and globalization: the triple processes underlying regional development in China. *Asian Geographer, 20*, 7–23.
Wei, Y. H. D. (2012). Restructuring for growth in urban China: transitional institutions, urban development, and spatial transformation. *Habitat International, 36*, 396–405.
Wei, Y. H. D., & Fan, C. C. (2000). Regional inequality in China: a case study of Jiangsu province. *The Professional Geographer, 52*, 455–469.
Wei, Y. H. D., & Li, W. M. (2002). Reforms, globalization, and urban growth in China: the case of Hangzhou. *Eurasian Geography and Economics, 43*, 459–475.
Wei, Y. H. D., & Liao, F. H. F. (2013). FDI embeddedness in production and innovation in China: strategic coupling in global production networks? *Habitat International, 40*, 82–90.
Wei, Y. H. D., & Ye, X. (2014). Urbanization, land use, and sustainable development in China. *Stochastic Environmental Research and Risk Assessment, 28*, 757–765.
Wu, F., & Yeh, A. G. O. (1997). Changing spatial distribution and determinants of land development in Chinese cities in the transition from a centrally planned economy to a socialist market economy: a case study of Guangzhou. *Urban Studies, 34*, 1851–1879.
Wu, W., Cao, Y., Cao, W., & Liang, S. (2009). Spatial pattern of regional comprehensive transportation cost—the case of Jiangsu province. *Scientia Geographica Sinica, 29*, 485–492 (in Chinese).
Yang, J., & Li, G. (2014). Fiscal and spatial characteristics of metropolitan government and planning in China: understanding centralization trends in a decentralization context. *Habitat International, 41*, 77–84.
Yeh, G. O. A., & Li, X. (1999). Economic development and agricultural land loss in the Pearl River Delta, China. *Habitat International, 23*, 373–390.
Yin, J., Yin, Z. N., Zhong, H. D., Xu, S. Y., Hu, X. M., Wang, J., et al. (2011). Monitoring urban expansion and land use/land cover changes of Shanghai metropolitan area during the transitional economy (1979–2009) in China. *Environmental Monitoring and Assessment, 177*, 609–621.
Yuan, F., Wei, Y. H. D., & Chen, W. (2014). Economic transition, industrial location and corporate networks: remaking the Sunan Model in Wuxi City, China. *Habitat International, 42*, 58–68.
Yue, W., Fan, P., & Wei, Y. H. D. (2014). Economic development, urban expansion, and sustainable development in Shanghai. *Stochastic Environmental Research and Risk Assessment, 28*, 783–799.

Zhang, T. (2000). Land market forces and government's role in sprawl: the case of China. *Cities, 17*, 123–135.
Zhao, R., Chen, Y., Shi, P., Zhang, L., Pan, J., & Zhao, H. (2013). Land use and land cover change and driving mechanism in the arid inland river basin: a case study of Tarim River, Xinjiang, China. *Environmental Earth Sciences, 68*, 591–604.
Zhu, J. (2004). From land use right to land development right: institutional change in China's urban development. *Urban Studies, 41*, 1249–1267.
Zhu, H. (2013). Underlying motivation for land use change: a case study on the variation of agricultural factor productivity in Xinjiang, China. *Journal of Geographical Sciences, 23*, 1041–1051.