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Central versus local states: Which matters more in affecting China's urban growth?

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ABSTRACT

To date, many geography studies have identified GDP, population, FDI, and transportation factors as key drivers of urban growth in China. The political science literature has demonstrated that China's urban growth is also driven by powerful economic and fiscal incentives for local governments, as well as by the political incentives of local leaders who control land use in their jurisdictions. These parallel but distinct research traditions limit a comprehensive understanding that can result in partial and potentially misleading conclusions of urbanization in China. This paper presents a spatially explicit study that incorporates both political science and geographic perspectives to understand the relative importance of hierarchal administrative governments in affecting urban growth. We use multi-level modeling approach to examine how socio-economic and policy factors – represented here by fiscal transfers – at different administrative levels affect growth in "urban hotspot counties" across three time periods (1995–2000, 2000–2005, and 2005–2008). Our results show that counties that are more dependent on fiscal transfers from the central government convert less cultivated land to urban use, controlling for other factors. We also find that local governments are becoming more powerful in shaping urban land development as a result of local economic, fiscal, and political incentives, as well as through the practical management and control of capital, land, and human resources. By incorporating fiscal transfers in our analysis, our study examines a factor in the urban development of China that had previously been neglected and provides an improved understanding of the underlying processes and pathways involved in urban growth in China.

Introduction

Studies of urbanization in China can be divided into two broad categories: spatially explicit studies and non-spatial studies. In the former category, researchers focus on monitoring, analyzing, and modeling the temporal–spatial patterns of urban growth mostly with the use of remote sensing images, geographic information, and socio-economic variables from statistical yearbooks (Liu et al., 2012a; Schneider and Woodcock, 2008; Seto and Fragkias, 2005). These geographical studies have identified GDP, population, FDI, and transportation factors as key drivers of urban growth in China (Deng et al., 2008; Fragkias and Seto, 2007; Long et al., 2007; Seto and Kaufmann, 2003; Wu and Zhang, 2012). In the latter category, the processes of urban growth are examined from the perspective of institutions, governance, and the power of states mostly with the use of in situ field investigations, participatory observations, interviews, governmental and archival documents, and analyses of official policies (Lin and Ho, 2005; Perlstein, 2012; Wallace, 2009; Wu, 2002; Zhang and Gao, 2008; Zhang, 2002). The political science literature has demonstrated that the urban growth is driven by powerful economic and fiscal incentives for local governments, as well as the political incentives of local leaders who control land use in their jurisdictions (Lichtenberg and Ding, 2009; Lin, 2009; Liu et al., 2012b; Zhang and Gao, 2008; Zhang, 2002).

These parallel but distinct research traditions limit a comprehensive understanding of urbanization in China because the approaches and insights have remained separate rather than informing each other. Importantly, without considering the roles played by institutions and governance in affecting urban growth in China, any spatially explicit analysis of the drivers of urban growth will result in partial and potentially misleading conclusions and will ultimately fail to effectively guide sustainable urban development. In addition, the true detailed processes and proper pathways included in the overall pattern of urban drivers and effects may not be revealed. We therefore argue that the incorporation of policy variables to spatially explicit urbanization studies will provide

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a more comprehensive framework for better understanding urban growth patterns and processes in China.

Given the aforementioned context, previous studies mostly interpret China's urbanization is driven by either the traditional drivers (such as GDP, population, and FDI) or non-spatial institutional factors separately. This leads to uncertainty as to whether all the spatially variant factors outside these identified drivers have been taken into account, which in turn leads to the key research questions in this paper: If some important factors have been missed, to what extent do they control urban growth in China? Does the inclusion of these policy or fiscal factors in a spatially explicit model of urban growth alter the established relationships of the standard drivers? Furthermore, as perhaps indicated by intergovernmental fiscal transfers, to what degree does the central government affect local decisions and urban growth at the local level? Is it central or local states that matters more in shaping local landscape? How important is the central–local relationship? How do these factors vary over time and across space in China? To date, spatially explicit studies of the hierarchical governments' roles in affecting urban growth and empirically modeling the relationship between intergovernmental fiscal transfers and urban growth in China remain underexplored, especially at the national level and in a systematic manner on the consistent and comparable longitudinal data. In order to fill in this knowledge gap, the primary purpose of this paper is to examine the degree to which the central government, local government, and central–local relationship affect urban growth in China by combining both political science and geographic perspectives.

Fiscal transfers and cultivated-urban land conversion

Conceptual framework for the relationship between fiscal transfers and cultivated-urban land conversion

Local governments operate under budget constraints. The expenditures expected from local governments often exceed their on-budgetary revenues. Faced with this difficulty, local governments finance expenditures through revenues accrued by the selling and transferring of land use rights (Fock and Wong, 2008; Oi and Zhao, 2007; Wong, 2007, 2012), while also utilizing transfer payments from higher levels of government. In this way, fiscal transfers can theoretically substitute for land use change at the local level, by providing the funds required of local governments to pay for their essential operations. Intergovernmental fiscal transfers account for a large share of local budgets, revealing the dependency of local economies on central government in the post-Tax Sharing System (TSS, *fenshuizhi*) environment. To some degree, fiscal transfers also represent the policy preferences of the central government. Therefore, investigating the relationship between fiscal transfers and cultivated-urban land conversion (hereafter land conversion) can improve our understanding of the interactions between and the relative importance of central and local governments in affecting China's urban growth.

Public finance reform and intergovernmental fiscal transfers

When the planned economy dominated the Chinese economy, the central government could manipulate prices in the economy to ensure that excess profits would be concentrated in a few firms; revenues would then be extracted from those excesses. With marketization came the destruction of the government's ability to collect revenue in this fashion as firms could sell goods at market prices outside of the plan rather than accept the substantially lower plan prices for their goods (Naughton, 1992). In 1988, the government created fiscal contracts with firms and provincial-level units to try to replace revenue lost due to marketization (Wong and Bird, 2008). This fiscal contracting system (*caizheng baogan*) put local governments on a self-financing basis for the first time and continued to erode the fiscal position of the central government (Wong, 1991; Wong and Bird, 2008; Wong et al., 1996).

The continuation of the central government's fiscal decline was finally put to a halt by the 1994 fiscal reform, which brought revenues that were commensurate with its political power to the center. The 1994 fiscal reform reverse the trend of the earlier reform era of a weakening central state. Rather, the 1994 reform as it reestablished control of the fiscal system to the central government from localities.

The most important component of the 1994 fiscal reform was the creation of the TSS. The TSS "fundamentally changed the way revenues are shared between the central and provincial governments, by shifting from a negotiated system of general revenue sharing to a mix of tax assignments and tax sharing" (Wong and Bird, 2008). The TSS divided all taxes into central, local and shared tax.[1] Most critically, 75% of the value-added tax (VAT), which accounted for almost half of all government tax revenue, were shifted to the central government with the remaining 25% for the local government (Wong and Bird, 2008). The TSS was a dramatic change. Prior to the TSS reform, local governments sent transfers to fund the central government. After the reform, local governments depended on transfers from the central government to pay for the operations, salaries, and facilities of local governments (Oi and Zhao, 2007). The 1994 fiscal reform changed the power of different levels of government – it strengthened the central government by claiming for itself a substantially larger share of revenues from the provinces (Li, 2010; Wong, 2000; Zhang, 1999). The expenditure assignment did not recentralize in accordance with the revenue; and the main responsibilities for public goods and services remained concentrated in local governments (Lin and Yi, 2011; Lin, 2009; Man and Hong, 2011).

Fiscal transfers data

Fiscal transfers data were obtained from *All China Prefecture City County Fiscal Statistical Data* (*Quanguo Di Shi Xian Caizheng Tongji Ziliao*), which are produced by the Ministry of Finance of China. We categorized the fiscal transfers data into internal revenues, tax rebates, and net fiscal transfers considering the availability and consistency of data at the county level over time. Internal revenues comprise taxes collected by local governments. The difference between internal revenues and total revenues equals the total fiscal transfers from central government to local states. Deducting tax rebates from total fiscal transfers yields net fiscal transfers. We developed indexes, such as total and net fiscal transfers as percentages of total revenue, to measure the dependency of local economies on fiscal transfers from the central government.

Between 1999 and 2004, Tibet had the largest fraction of total fiscal transfers as percentages of total revenue, at 84.2%, and Fujian had the smallest percentage, at 35.6%. During this same period, Tibet also had the largest share of net fiscal transfers, at 79.2%, while Jiangsu is the smallest at 18.7% (Fig. 1). That a larger fraction of fiscal transfers went to less developed provinces reflects the national policy to develop western regions and revitalize the old industrial base of northeast China.

At the county level, there was a geographic gradient in the total and net fiscal transfers as percentages of total revenue. In general,

[1] The TSS divided all taxes into three categories: central, such as tariff and consumption tax; local, such as business tax, urban maintenance and construction tax, housing property tax, and fixed asset investment tax; and shared, such as value-added tax (VAT), and corporate and personal income tax.

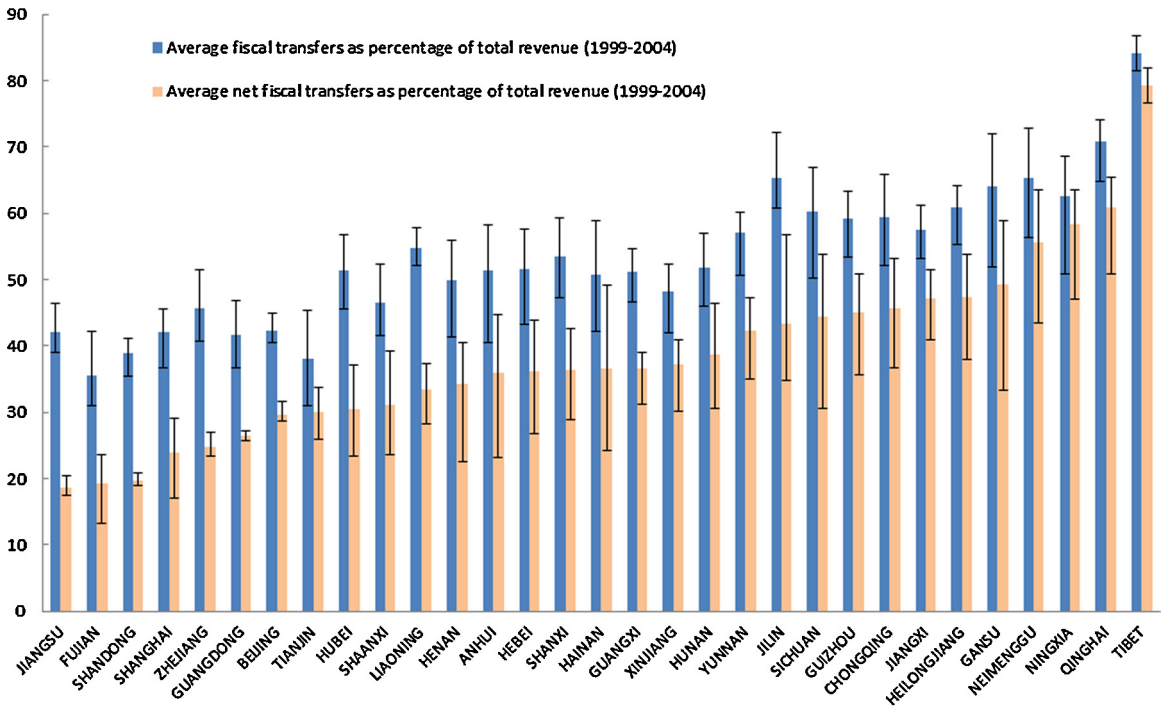

Fig. 1. Total and net fiscal transfers as percentage of total revenue at province level (1999–2004).

the amount of total and net fiscal transfers is highest in the west and decline moving across the country eastward (Fig. 2). Moreover, most western counties have very high per-capita total and net fiscal transfers. Per capita totals and net fiscal transfers for Beijing, the Pearl River Delta, and the Yangtze River Delta are higher than those for the other eastern counties, reflecting the national priority of continued investments and development in these regions.

Correlations between fiscal transfers and cultivated-urban land conversion

To investigate whether the pattern of fiscal transfers is related to land conversion, we used the Chinese Land Cover Dataset (CLCD), developed from Landsat TM/ETM+ images for all Chinese counties (Liu et al., 2002, 2003, 2012a).

Considering the time lag between the fiscal transfers and subsequent land conversion, we summarized the fiscal transfers for 1999–2004 and the land conversion data for 2000–2005. We assume that the fiscal transfers from the central government to local states between 1999 and 2004 have an effect on land conversion during the 2000–2005 period. We use three different approaches to examine net fiscal transfers and their effects on conversion of cultivated land: (1) net fiscal transfers per capita; (2) net fiscal transfers; and (3) the share of local government revenues constituted by net fiscal transfers.

At the county level, there is little correlation between per capita net transfers and land conversion, regardless of whether the conversion is from cultivated land to built-up areas (CL-BU) or from non-built-up to built-up areas (NBU-BU), or the conversion rate from cultivated land to built-up areas (CL2BU_BU2K). The value of net fiscal transfers (NFT), however, is positively correlated both with general levels of economic activity (GDP) and with land conversions. This suggests that more cultivated land is converted to urban uses in developed counties that receive a larger total amount of net fiscal transfers.

Finally, the composition of local government revenues, and in particular net fiscal transfers as a percentage of local revenue (*NFT_share*), is negatively correlated with the number and rate of land conversions. This can be interpreted in two ways. First, local governments that are less dependent on transfers from the central government have to convert land to pay the bills. Second, local governments that are more dependent on transfers from the central government may either feel obligated to follow government legislation to restrict cultivated land conversion to urban uses, or pay their essential operations by using the funds from and fiscal transfers that substitute for land use change at the local level (Table 1).

Multi-level models and variable specifications

Following our exploratory data analysis that confirmed a relationship between the composition of local government revenues and the number and rate of land conversions, we developed a model to examine the relationship between fiscal transfers and land conversion in urban hotspot counties that defined as counties that have experienced higher rates of urban growth compared to other counties. We use urban hotspot counties because we are interested in the areas which experienced rapid urban growth. We used 246 urban hotspot counties (Fig. 3) which were identified using the U.S. Air Force Defense Meteorological Satellites Program/Operational Linescan System (DMSP/OLS) night-time light satellite data for the period 1992–2008 (Jiang et al., 2012).

Our dependent variable is *ConvertedLand*, which is the amount of land in a county converted from agriculture to urban uses for each of the three time intervals: 1995–2000, 2000–2005, and 2005–2008 (Table 2). Time is represented by two dummy variables, *td*1 and *td*2: *td*1 = 0 and *td*2 = 0 for 1995; *td*1 = 1 and *td*2 = 0 for 2000; and *td*1 = 1 and *td*2 = 1 for 2005. Fiscal transfers from the central government for each county were constructed as the amount of net fiscal transfers divided by total revenue in that county as a measure of the dependence of local fiscal revenue on central government.

Based on previous empirical studies (Jiang et al., 2012; Seto and Kaufmann, 2003), per capita GDP (*pcGDP*) and land rent ratio (*LandRentRatio*), the latter which is defined as the ratio between agricultural land rent and urban land rent in a county, were selected

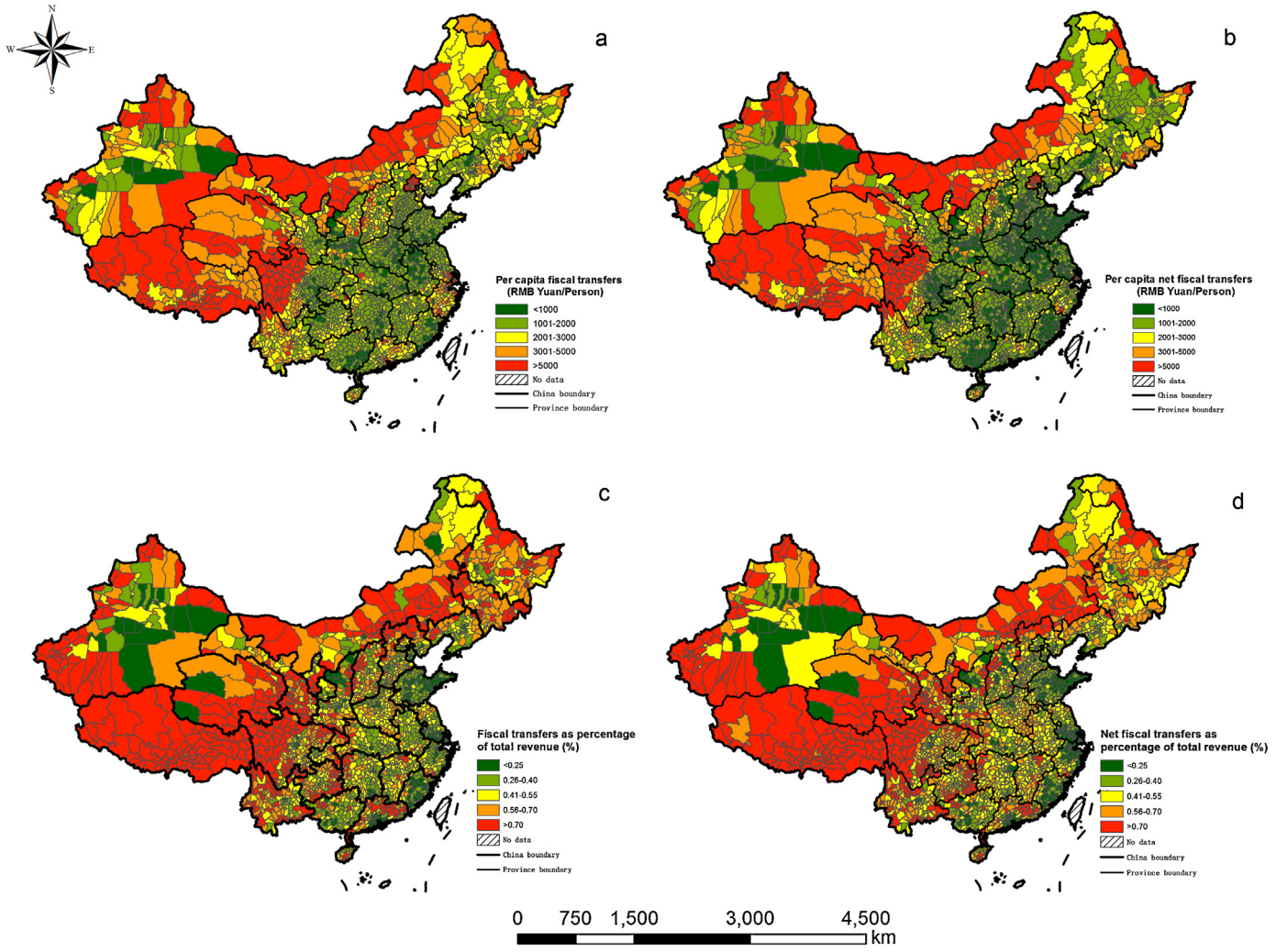

Fig. 2. Fiscal transfers for counties (1999–2004). (a) Per capita total fiscal transfers. (b) Per capita net fiscal transfers. (c) Fiscal transfers as proportion of total revenue. (d) Net fiscal transfers as proportion of total revenue.

as measures of social and economic structure. Due to the lack of consistent information about land rent across counties, we used the value of gross agricultural output divided by cultivated land area as a proxy for agricultural land rent. Following Seto and Kaufmann (2003), we used the value of gross industrial and service sector output divided by urban land area as a proxy for urban land rent. Small land rent ratios are expected to provide the opportunity to make profits because of rent differences, and result in land conversion from cultivated to urban uses. We also included group of biophysical variables that represent spatial heterogeneities and locational advantages to control for time-invariant spatial heterogeneities in a county (Deng et al., 2008; Jiang et al., 2012; Zheng et al., 2009). These included the distance to provincial capital cities (*DisPCap*), the ratio of land with a slope of less than eight degrees (*PlainRatio*), and the average annual precipitation (*Precipitation*) and average annual air temperature (*Temperature*) for the period 1950–2000. Details of the data sources used for the socio-economic and biophysical variables are reported in Jiang et al. (2012).

Our analysis consists of three steps. In the first step, we select the suitable models to match the characteristics of our data. Our data set is organized hierarchically: multiple measurements of land use change are nested in a county and each county is nested in a province. Moreover, our data are longitudinal. In this regard, our data differs from many existing studies that examine the role of institutions and governance for only one point in time and not over time. Previous studies show that an ordinary regression model is an

Table 1
Correlations between land conversion (2000–2005) and fiscal transfers (1999–2004).

	GDP	NFT	pcNFT	OR	Lg(OR)	IR	Lg(IR)	*NFT_share*
NFT	0.8100	1						
pcNFT	0.2308	0.4413	1					
OR	0.9473	0.9151	0.3556	1				
IR	0.9559	0.8639	0.3184	0.9918	0.4458	1		
NFT_share	−0.2914	0.0354	0.3903	−0.1675	−0.4231	−0.2036	−0.7336	1
CL-BU	0.5063	0.2598	0.0609	0.3924	0.4999	0.4084	0.4797	−0.3147
NBU-BU	0.5531	0.2991	0.0836	0.4472	0.4890	0.4688	0.4748	−0.3156
CL2BU_BU2K	0.1130	0.0390	0.0810	0.0821	0.1647	0.0856	0.1769	−0.1608

Table 2
List of variables used in multi-level models.

Variable	Description
Dependent variable	
ConvertedLand	Area of land converted from cultivated to urban uses in a county within 1995–2000, 2000–2005, and 2005–2008 intervals (ha)
Independent variables	
County level	
*td*1, *td*2	Dummy variables for time. Year 1995: $td1 = 0$, $td2 = 0$; Year 2000: $td1 = 1$, $td2 = 0$; Year 2005: $td1 = 1$, $td2 = 1$
NFT_share	Net fiscal transfer from central government as percentage of a county's total revenue $\frac{\text{Total Revenue}-\text{Internal Revenue}-\text{Tax Refund}}{\text{Total Revenue}}$ (%)
pcGDP	Per capita GDP of a county (Chinese Yuan)
LandRentRatio	$\frac{\text{GDP in agricultural sector/area of agricultural land (in a county)}}{\text{GDP in industrial and service sector/area of urban land (in a county)}}$ (%)
DistPCap	Distance from the county seat to the provincial capital (m)
PlainRatio	Ratio of land with a slope less than eight degrees in a county (%)
Precipitation	Average annual precipitation in a county (mm)
Temperature	Average annual air temperature in a county (°C)
Province level	
NAGDP_share_p	Non-agricultural GDP as percentage of total GDP within a province (%)

Table 3
Multi-level models for the conversion of cultivated land to urban land.

	Dependent variable: *Log*(*ConvertedLand*)					
	Model A	Model B	Model C	Model D	Model D′	Model E
Random effects (*z* value)						
Within county						
σ^2_ε	1.1692 (13.16)***	1.1937 (13.37)***	1.1996 (13.53)***	1.2371 (14.45)***	1.1977 (13.57)***	1.2288 (14.42)***
ρ_ε	0.524	0.642	0.698	0.722	0.712	0.703
Between counties						
$\sigma^2_{\mu 0}$	0.5621 (4.72)***	0.3007 (3.10)***	0.0885 (1.14)		0.0997 (1.27)	
$\sigma^2_{\mu 1}$	0.3682 (2.38)***	0.3293 (2.36)***	0.3049 (2.34)***	0.3672 (3.23)***	0.2830 (2.22)**	0.3988 (3.39)***
σ^2_μ	0.9303	0.63	0.3934	0.3672	0.3827	0.3988
ρ_μ	0.416	0.338	0.229	0.214	0.228	0.228
Province level						
σ^2_v	0.1338 (1.73)**	0.0365 (0.86)	0.1244 (1.71)**	0.1095 (1.65)**	0.1002 (1.52)*	0.1206 (1.67)**
ρ_v	0.060	0.020	0.073	0.064	0.060	0.069
Fixed effects (*t* value)						
Intercept	4.7966 (37.69)***	5.5416 (38.03)***	8.7675 (6.18)***	6.7782 (4.17)***	6.6931 (4.05)***	6.7055 (4.05)***
*td*1	1.4233 (12.91)***	1.1761 (10.18)***	1.2250 (10.59)***	1.1034 (8.50)***	1.1052 (8.69)***	1.0875 (8.33)***
*td*2	−0.3431 (−3.34)***	−0.4542 (−3.73)***	−0.4410 (−3.61)***	−0.5526 (−4.18)***	−0.5436 (−4.15)***	−0.6637 (−5.41)***
NFT_share		−0.8707 (−2.48)**	−0.7344 (−2.13)**	−0.7722 (−2.23)**	−0.8208 (−2.39)**	
Log(*pcGDP*)		0.5325 (5.31)***	0.4497 (4.50)***	0.4366 (4.52)***	0.4124 (4.13)***	0.4966 (5.30)***
LandRentRatio		−0.0251 (−2.46)**	−0.0211 (−2.23)**	−0.0179 (−1.94)**	−0.0189 (−1.98)**	−0.0204 (−2.22)**
Log(*DistPCap*)			−0.2878 (−4.29)***	−0.3025 (−4.70)***	−0.3083 (−4.57)***	−0.2975 (−4.59)***
PlainRatio			0.0084 (4.51)***	0.0078 (4.36)***	0.0077 (4.15)***	0.0079 (4.34)***
Log(*Precipitation*)			−0.6990 (−2.98)***	−0.7569 (−3.38)***	−0.7411 (−3.21)***	−0.7667 (−3.37)***
Log(*Temperature*)			1.5680 (4.20)***	1.6677 (4.67)***	1.6520 (4.49)***	1.7309 (4.77)***
NAGDP_share_p				2.9630 (2.16)**	3.0938 (2.24)**	2.6718 (1.92)*
AIC	2313.5	2255.4	2195.8	2188.0	2188.2	2192.6

*** $p < 0.01$.
** $p < 0.05$.
* $p < 0.1$.

inappropriate approach if the data are organized in a hierarchical structure (Hoshino, 2001), because even a small intra-class correlation coefficient (ICC) could cause a large type I error in model estimation (Wang et al., 2011). Because of the structure of the data, we use a multi-level modeling approach for analyzing clustered data with a hierarchical and longitudinal structure (Gelman and Hill, 2006; Luke, 2004). In the second step, we identify the optimal base model specification. We used established procedures in the literature to build a series of empty models (models without any explanatory predictors except time variables) and selected the optimum one as the base model for including explanatory variables at different administrative levels. For all models used in this paper, *i*, *j*, and *t* index counties, provinces, and time, respectively. Specifically, using county-level (μ_{0ij}) or province-level (v_{0j}) random intercepts, we assume only that the response randomly varies among counties or provinces accordingly. Using county-level random slopes interacting with either or both of the time dummy variables ($\mu_{1ij}td_1$, $\mu_{2ij}td_2$), we assume that the relationship between time and the response randomly varies among counties. Taken together, we produce 15 various combinations ($C_4^1 + C_4^2 + C_4^3 + C_4^4 = 15$) of county-level random intercepts, county-level random slopes, and province-level random intercepts when we fitted models[2] (labeled as Eq.1 to Eq.15 in Fig. 4, Step 2). We applied a restricted maximum likelihood (REML) estimator[3] for the model estimation (Verbeke and Molenberghs, 2000). In order to select the optimum model, we use univariate tests of the individual variance

[2] In Fig. 4, Step 2, the component that is linked by a line is included in the equation, for example, Eq.6 can be presented as $Y_{ijt} = \beta_0 + \beta_1 td_1 + \beta_2 td_2 + \mu_{2ij} td_2 + \mu_{2ij} + \mu_{0ij} + e_{ijt}$.

[3] Restricted maximum likelihood (REML) estimator borrows information from all the groups to support statistical estimation for those groups with insufficient observations (Gelman and Hill, 2006), and includes a shrinkage function similar to the empirical Bayes estimator (Carlin and Louis, 2009).

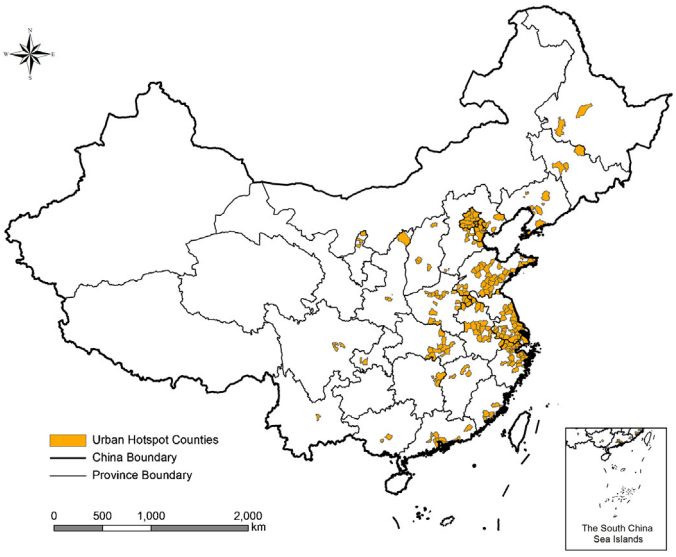

Fig. 3. Urban hotspot counties identified using DMSP/OLS data.

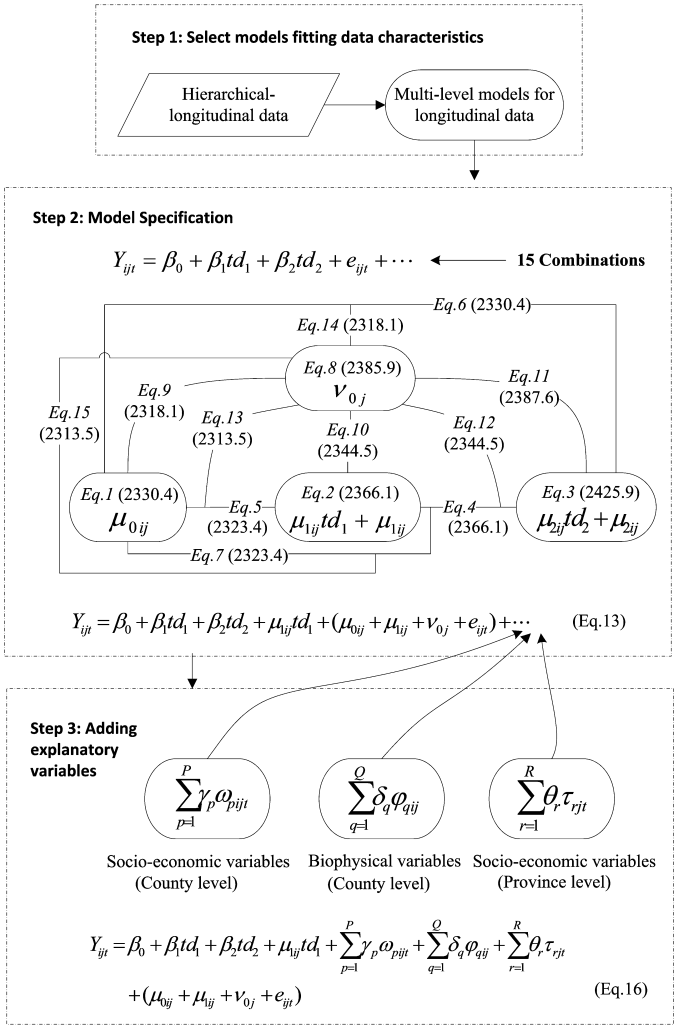

Fig. 4. Flowchart of multi-level modeling developed for longitudinal data.

components and multivariate tests of overall model fit. For all models, the smaller the Akaike information criterion (AIC) values (the numbers in the brackets, Fig. 4, Step 2), the better the model fits the data. Our results show that Eq.13 was the optimal base model not only because it has the smallest AIC but also because the variances of all random effects are statistically significant.[4] In the third and final step, we sequentially included the three sets of explanatory variables: socio-economic, biophysical, and province-level (Table 3, Models B–D), to the selected optimal base model (Table 3, Model A) and estimated the effects of socio-economic factors at different administrative levels on the urban conversion of cultivated land (Eq.16 in Fig. 4, Step 3). In order to highlight the variable of fiscal transfers, we removed it from Model D and listed the estimation outcome as Model E.

Results and discussion

Based on a likelihood ratio test using Chi-square (χ^2) and degrees of freedom (*df*), Models A and B, B and C, C and D, and D and E are significantly different.[5,6] Continuously declining AIC values from Model A to Model D indicate that the models progressively better fit the data. In addition, the signs of all coefficients are consistent, and the values for all coefficients are very similar. Put together, they suggest that the models are robust and all three groups of variables contribute to the explanation of land conversion to urban uses. The results indicated by ICC value in base Model A confirm the need to use a multi-level modeling approach (Luke, 2004; Wang et al., 2011). Compared to the curvilinear growth model, for instance, the quadratic model structure in which year and year-squared are incorporated (Jiang et al., 2012), our model with two time dummy variables provides a more accurate fit to the data and the coefficients are much easier to understand and interpret.

As expected, a proportion of the variability associated with the base model is accounted for with the models progressively better fitting the data and the variances in the two higher level random terms generally decrease (except σ_v^2 in Model B) by sequentially including explanatory predictors. Significant random effects at both county and province levels suggest that random intercepts and slope are required to adequately represent the nested nature of the underlying processes, which could not captured by regular regression.

From the results, the 52.4% of the total variance attributable to the variation within counties and the 41.6% to the variation between counties within the same province together account for 94% of the total variance, leaving only 6% to the variation between provinces. Adding county-level socio-economic and biophysical variables decreases the between-county variance dramatically from 0.93 in Model A to 0.63 in Model B and to 0.39 in Model C. In other words, 57.7% of the decline in between-county variance can be accounted for the degree of dependence on fiscal transfers, socio-economic level, and the locational advantages of counties. Similarly, 12% of the province-level variance can be explained by the province-level variable, non-agricultural GDP as percentage of total GDP within a province. County-level variables contribute to 6.2%

[4] The variances of three random effects ($\sigma_{\mu 0}^2$, $\sigma_{\mu 1}^2$, and σ_v^2) in Eq.13 are statistically significant, supported by $p < 0.01$; $p < 0.01$ and $p < 0.05$.

[5] To confirm the composition of variance of between-county (by testing whether $\sigma_{\mu 0}^2$ recovers significant when adding new group of variables), we introduce Model D′ that the variance of between-county comes from random intercepts ($\sigma_{\mu 0}^2$) and slopes ($\sigma_{\mu 1}^2$) as a comparison to Model D. Models D and D′ are not significantly different as indicated by $p = 0.18$, consequently, we omitted this random item in the full model D.

[6] Likelihood test results for Models A and B, B and C, C and D, D and E are $p < 0.0001$, $p < 0.0001$, $p = 0.016$, and $p = 0.011$ correspondingly.

decrease of province level variance. Province-level variable also contributes to the decrease of between-county variance from 57.7% to 60.5%. The results suggest that local and regional factors are interactional although the mechanisms by which they affect each other are not completely clear based on the model results. The results also indicate that the overall local factors play a relatively important role in determining urban growth as the proximate drivers in spite of the significant effect of the regional factors have taken.

The signs on the coefficients for all variables are consistent and the differences in their magnitudes are minor, even when more predictors are added into the model. All fixed effects estimated for the growth models have statistically significant impacts on the expansion of urban land at the expense of cultivated land. These include the fixed effects for the fiscal transfer factor, socio-economic variables, and biophysical variables at county level, and for the socio-economic variables at province level. Using the most comprehensive model (D) with the smallest AIC, we can illustrate the effect of each variable as follows.

The variable in which we are most interested, fiscal transfer from the central government as a percentage of a county's total revenue, has a statistically significant negative effect on the area of land converted from cultivated to urban uses. That is, the amount of land converted from cultivated to urban use is greater in counties that are less dependent on fiscal transfers from central government. These counties that are less reliant on fiscal transfers might have stronger incentives to make profits from leasing land for off-budgetary revenue, which can be taken as evidence of powerful local states at the county level affecting urban growth. Local governments seek and depend on new off-budgetary revenue sources through expropriating cultivated land and transferring land use rights to developers; this phenomenon has attracted widespread media attention (Huang, 2010; Wu, 2010) and research attention (Lin, 2007, 2009; Lin and Yi, 2011; Man and Hong, 2011; Oi and Zhao, 2007), but is seldom examined in empirical studies of the drivers of urban growth at the national level in a spatially explicit way. The significant difference between Models D and E as discussed above confirms the importance and necessity of incorporating this factor.

In all models, holding all the explanatory variables at both county and provincial levels unchanged, the area of land converted in the period 2000–2005 exceeds that in the period 1995–2000 as shown by the statistically significant positive coefficient estimate of *td*1. Similarly, for the same socio-economic and biophysical conditions, the area of land converted in 2005–2008 is less than in 2000–2005 as illustrated by the statistically significant negative coefficient of *td*2, although this is not strictly comparable because the time interval is not the same. However, the area of converted land is still larger ($1.1034 - 0.5526 > 0$) in 2005–2008 than in 1995–2000, keeping all predictors unchanged. This suggests that urban growth placed less pressure on cultivated land in urban hotspot counties during the period 1995–2000 than during the two subsequent periods of interest. This is consistent with the series of land regulations enacted by the national government in this period; for example, in 1998, the Ministry of Land and Resources (MLR) was set up to replace small land offices under other ministries; the central government amended the "Land Administration Law" and the "Regulations for the Protection of Basic Farmland" to strengthen the protection of farmland in the same year (Lichtenberg and Ding, 2008; Liu et al., 2005b). This also confirms previous findings regarding China's land use patterns in the late 20th and early 21st centuries (Liu et al., 2005a, 2012a; Tan et al., 2005).

Interestingly but contrary to expectations, the results also show that the same dependence on fiscal transfers in 2000–2005 will result in higher amount of land conversion than in 1995–2000. This indicates the increasing trend of making profits through selling land for local governments in 2000–2005 than in 1995–2000 although the central government imposed repeated policies to increase the transparency of land market operation and recentralize state power in land management (Table 4). One possible reason is that land is still transacted in a non-transparent way in most Chinese cities and enforcement of these policies is very difficult (Lin and Ho, 2005; Zhu, 2002). This also suggests an unsuccessful reduction of the discretion of local governments in land governance to some extent, although the central government took a series of strategies to cool down the overheated local economies and achieve a more centrally consolidate power.

The coefficient estimate associated with *Log*(*pcGDP*) has a positive value. This suggests that the per capita GDP boosts the urbanization process and simultaneously has a negative effect on protecting cultivated land within these hotspot counties. Compared to less developed counties within the same province, more developed counties are more likely to urbanize. *LandRentRatio*, a proxy of the ratio of agricultural land rent to urban land rent in a county, is negatively correlated with the urban conversion of cultivated land, confirming previous studies (Jiang et al., 2012; Seto and Kaufmann, 2003). This indicates that counties with lower land rent ratios experience greater amounts of conversion from cultivated to urban land. In other words, cultivated land is more prone to be converted to urban uses if the urban rent is significantly greater than the rural rent. Similarly, converting land to urban uses is a less attractive proposition if the returns on agricultural uses are high; therefore, raising the returns on cultivated land may be an option for protecting cultivated land (Long and Zou, 2010).

As indicated by the negative coefficient for *Log*(*DistPCap*), counties that are closer to the provincial capital undergo greater amounts of cultivated land conversion. Proximity to the administrative, economic, demographic, and transportation center of a province, presents locational advantages for urban development, such as convenient transportation and infrastructure, better market access and vigorous labor market. As indicated by the positive coefficients for *PlainRatio* and *Log*(*Temperature*), and negative coefficients for *Log*(*Precipitation*), cultivated land in counties is prone to be converted to urban uses when the county is relatively warm, dry, and topographically flatter with other variables controlled for. These regions are more attractive to overseas investors who consider environmental amenities in their locational choices (Deng et al., 2008; Zheng et al., 2009).

Provincial variables provide contextual information about regional economic conditions, and therefore extend our understanding of how regional factors affect urban growth and cultivated land loss at the local level in the urban hotspot counties. As expected, the province-level variance of the model that incorporated the provincial variable *NAGDP_share_p* (the non-agricultural share of GDP) is lower than that of model without this variable.[7] In China's statistical data, the sectors considered as part of industry include manufacturing, construction, transportation, and communication and commerce, and the sectors considered as part of the service category include transport, postal and telecommunication services, wholesale, retail trades, and catering services.[8] *NAGDP_share_p*, an indicator of economic structure, has a significant positive impact on the area of land converted to urban uses. It implicitly suggests an aggregation effect whereby urbanization occurs preferentially in regions that are already highly urbanized. This is consistent with previous studies of the role of industrialization in affecting urban growth in China (Deng et al., 2008).

[7] We also tested some other provincial variables, such as total GDP, urban population, FDI, and urban wage, but none of them was statistically significant due to the sizes of their correlations with socio-economic variables at county level.

[8] Definition and detailed explanation is provided by National Bureau of Statistics of China. http://www.stats.gov.cn/tjzd/tjzbjs/t20020327_14293.htm (in Chinese).

Table 4
Policies and decrees to recentralize the state power in land management.

Time	Institutes[a]	Policy/decree	Main contents
October 2001	MLR	"Directory of Allocated Land"	Administrative land allocation to commercial projects is abolished.
March 2002	MLR	No.11 decree "Regulation of Granting State-owned Land Use Right by Tender, Auction and Quotation"	All land for business purposes (commerce, tourism, entertainment and commodity housing) is required to be transferred publicly after July 1, 2002 either through tender, auction or quotation.
March 2004	MLR and MS	No.71 decree "Inspection on continuously granting state-owned land use right by tender, auction and quotation"	Transferring land use right through contract and negotiation is thoroughly terminated, and the strict deadline for it is August 21, 2004.
July–December 2003	MLR, SC1, GOSC, SC2, NDRC, AA	Suspend the approval of new development zones and clear up existing illegal development zones	6015 illegal development zones that covers 35,400 km^2 across China are cleared up; hierarchical administrative system of the land management department.
October 2004	SC1	the decision of the State Council on further carrying out the reform and vigorously conducting land administration	Not reducing the total amount and quality of existing basic farmland must be pledged; any unit or individual could not occupy the basic farmland or authorize the change of use once the basic farmland that has been designated; idling land is strictly prohibited.

[a] *Institutes*: Ministry of Land and Resources (MLR); Ministry of Supervision (MS); The State Council (SC1); General Office of the State Council (GOSC); Ministry of Construction (SC2); Auditing Administration (AA); National Development and Reform Commission (NDRC).

Given that the factor of fiscal transfers plays an important role in affecting urban land development, what are the underlying motives for local governments to make profits from leasing land? First, there are powerful economic incentives for local officials to increase their revenue by obtaining rural land and transferring land use rights to developers (Long et al., 2009, 2012). With the land reforms of the 1980s, long-term land use rights could circulate freely in the market. Local governments earn profits through expropriating land from farmers at a low price and then leasing land to land developers and enterprises by means of auction, public tender, or open bidding at a high price. Local governments believe that pro-growth and expansionist policies are essential to sustain growth and that the implementation of such policies requires lots of land (Xu and Yeh, 2009). As the practical land administrators, local governments are involved in the land market as land developers (Lichtenberg and Ding, 2009; Perlstein, 2012) and the revenue from these transactions can amount to as much as 40% or more of a city's budget (Man and Hong, 2011). Local governments can further increase their profits by collecting taxes from enterprises, land developers, and commodity consumers.

Second, the powerful fiscal incentives for local governments to expand their developed areas are well documented in the Chinese and political science literatures (Gong, 2006; Jin et al., 2005; Skinner et al., 2001). One component of such incentives was the decentralization of responsibility to lower-level governmental units, which encouraged city governments to work harder to raise revenue for supporting local economic growth. With further fiscal reforms in the mid-1990s, in which localities were required to share a greater proportion of their tax revenue with the central government, cities continued to look to land leasing as a key revenue source controlled entirely at the local level. Various tax-free extra-budget and off-budget accounts are maintained by local governments, which in turn enables local governments to generate revenue (Qian and Weingast, 1997; Xu and Yeh, 2009).

Third, there are also political incentives for local officials to undertake urban development. Since the 1990s, top officials of provinces and cities, including mayors and party secretaries, have been promoted upwards in the government hierarchy or rotated to leadership posts in different cities and provinces. Furthermore, while a standard term in a given post is 4–5 years for these local officials, there is high variability because tenure is often shortened by frequent reshuffling of personnel. In practice, local governments control both the ownership and the development rights of urban space through the granted property rights of urban land by the Land Administration Law (1998) and development permits by the City Planning Act (1989) (Wu et al., 2006; Xu and Yeh, 2009). Moreover, local governments also have the power to abandon old urban centers and build new city centers, as well as to physically force people to move to new city centers in some places (Liu et al., 2012b). Therefore, local governments as the major stakeholders play important roles in shaping the urban landscape because they control the flow of capital, land, and labors, the triad of production factors that are highlighted as the fundamental forces underlying the growth in China (Lin, 2007, 2009).

However, powerful local states do not necessarily mean that the role of central state is not important in shaping local landscape. Actually, the fact that *NFT_share* is a vital factor to explain land conversion simultaneously confirms that central government also plays an important in shaping local urban landscape. There has been significant devolution of administrative powers to local level governments in the last two decades, but the hierarchical nature of the top-down polity remains (Chan, 2010). The task of the central government is to promote effective land use and the preserve farmland by establishing a fully-fledged land market and controlling rapid urban expansion (Wu et al., 2006). Policy preferences dictate the way in which central government formulates the macro-development plans for the whole country and allocates subsidies. The central government's strategies decide both the direction and emphasis of development for hierarchical governments. The central government approves regional planning and selects different places as priority or restricted development areas, and then adopts and promotes successful experiences from local experiments. This provides contextual information about regional development conditions. Besides the powerful local states, the central government tried to retain some important influence over land policies. For instance, regulated by 1998 Land Administration Law, major tasks in land administration are taken back by provinces and the central government, leaving few duties to local governments in terms of making any important land use decisions; the central government required the local off-budget land leasing income to be totally incorporated into the local budget account in 2006. Moreover, only the central government (i.e. the State Council) has the authority to designate a settlement as a city or designated town, and promote cities on the urban hierarchy system. In addition, recently, the central government, through its key authorization function in large projects, such as CBDs, convention and exhibition

centers, large urban renewal projects, development zones and university towns, together with site selection for overseas plants, have had greater impacts on urban land conversion, as well as physical form and social space (Xu and Yeh, 2009). Starting in early 1990s, China began to reform its central administrative organizations and restructure some institutions of the central state in the local territory to enhance their roles in economic regulation. MLR, the People's Bank of China and State Administration of Taxation are cases in point.

Recently, some scholars theoretically argued with examples that it would be too simplistic to interpret the state reconstruction only in terms of the decline of the central government and the rise of local authorities (Xu and Yeh, 2009). To better understand the roles of states in affecting urban land development, we cannot ignore the interactions between local and central states. Given the top-down configuration of power, local authorities always have incentives to compete each other and be upgraded to a higher administrative rank for obtaining central policy interest, allocation of resources and the opportunities, more fiscal resources and stronger political/administrative power (Chan, 2010; Lin and Yi, 2011; Ma, 2005; Xu and Yeh, 2009). Concentrating on land governance, hierarchically, land departments at the lower-level are subordinated to the next higher level land department in terms of personnel appointment and technical guidance, for example, key officials in cities such as Shanghai, Beijing and Zhengzhou have been fired because they ignored central orders and violated national land policies. Consequently, the hierarchical linkages are strengthened. However, local land departments are still dependent on the local states for finance territorially, for example, officials salaries, and working activities and expenditures of local land departments are administrated by local governments. One cannot deny that the local state has, in effect, a controlling role over land issues through its financial responsibilities. This flawed vertical hierarchical land management system is unfavorable for the strict implementation of state land management policy.

In sum, the multi-level longitudinal models presented in this study show that local factors such as fiscal transfers share, land rent ratio, and per capita GDP play a dominant role in determining urban growth. Moreover, much more of the variance in multi-level models of the conversion of cultivated to urban land derives from the county level rather than the province level, which demonstrates the relative importance of local versus regional socio-economic factors to urban growth. Taken together with the discussion of local and central state influences, it seems that local governments are becoming increasingly powerful in making decisions regarding local affairs and in shaping local urban landscapes, although the central–local interactions and the roles of central states played could not be neglected.

Although robust results have been obtained from this study, we are cautious to extend the interpretations to all urban land conversion from natural ecosystems such as forest and grassland given that we only examine urban land expansion from cultivated land. This study of urban hotspot counties cannot be taken as representative of the entire country as well. Nevertheless, this study of urban hotspot counties can generate significant insights into the nature of land conversion after incorporating political perspectives into a spatially explicit study. Furthermore, an evaluation of the successful and unsuccessful experiences of urban hotspots counties that experiencing rapid change and have moved "one step ahead" of the country in regional development can yield important lessons for other Chinese regions that are yet to struggle for rapid economic growth.

Several other limitations apply to this study. First, we used a 1-year lag-effect in the study, and different lags and cumulative effects due to the nature of fiscal transfers could be investigated with the support of a longer data time series. Second, owing to the lack of detailed categorical information on net fiscal transfers, the transfers were taken as an aggregated variable in this study. However, fiscal transfers can be classified into general-purpose transfers (which are designed to reduce the revenue gap between rich and poor regions), and specific-purpose or conditional transfers (which are commonly used by the central government to provide incentives for local governments to undertake specific policies, programs, or activities favored by the central government). Specific transfers can be further categorized into fiscal capacity balancing transfers and earmarked transfers, with the latter currently comprising the vast majority of transfers in China (43.3% of the total transfers and 63% of the total specific-purpose transfers) (Huang and Chen, 2012). Earmarked transfers are program-based and allocated for specific purposes, and usually require matching funds from the recipients. The allocation of funds via this type of transfer is not formula-based, but rather is closely related to political influence and to the bargaining power of individual provinces. There are more than 300 types of grant under the control of approximately 15 central ministries and are thus beyond the supervision of the Ministry of Finance and National People's Congress (Zhou and Yan, 2008), and which also perplex the data collection. Further research, examining the effects of detailed categories of fiscal transfers on urban land expansion, will shed more light on the drivers of urbanization and on decision-making regarding the better allocation of fiscal and land resources.

Bearing in mind the above caveat, one can still observe that substantial differences across counties in the amount of converted land that can be explained by policy factors, namely dependence on fiscal transfers from higher levels. Given that China's urban planning and regional development have become increasingly decentralized and unstructured, the multi-level model allows us to take account of this new trend of urbanization and test differences in urban planning strategies across regions and time periods.

Conclusions

Bringing a political science perspective to the spatially explicit study of urbanization in China improves the understanding the patterns, processes, and causes of urban growth over time and across space. Accounting for policies implemented by multi-level governments provides a more nuanced and richer understanding of the factors that shape urbanization than do traditional socio-economic factors such as population and economic growth alone.

Our study sheds some light on the control of future urban growth and cultivated land loss in urban hotspot counties. According to empirical studies, fiscal transfer from central to local governments is a significant factor affecting urban growth in China. The area of land converted from cultivated to urban uses is greater in counties that are less dependent on fiscal transfers. The factors of fiscal transfers have been neglected in most previous studies of the drivers of urban land change. Without taking into consideration these important factors, the processes and pathways revealed in the overall pattern of urban land conversion and the underlying driving forces cannot be properly understood. Although regional factors significantly affect urban growth, the results here mainly show that local governments are more powerful than the central government in shaping urban land development because of economic, fiscal, and political incentives, as well as because of local governments' control and management of capital, land, and labors. Contrary to expectations, the increasing trend of making profits through selling land for local governments in 2000–2005 than in 1995–2000 suggests an unsuccessful reduction of the discretion of local governments in land governance to some extent. In this case, effectively and strictly inspection of the policy execution is important for the success of the policy.

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