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A spatial panel statistical analysis on cultivated land conversion and chinese economic growth

Jianping Liu, Qingbin Guo *

School of Business of Hubei University, Wuhan 430062, PR China

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ABSTRACT

The conflict between cultivated land protection and economic development has become increasingly acute in recent years. Despite, intensive researches made on this conflict, little attention has been paid to the spatial correlation of variables. In view of this, the paper introduces the spatial panel regression model to estimate, and test whether the relationship between economic growth and cultivated land conversion conforms to Kuznets curve. Research results show that the area of converted cultivated land in China exhibits strong spatial auto-correlation; the spatial panel model with time effect and fixed effect is more stable and significant than conventional panel mode, and that the relationship between economic growth and cultivated land conversion agrees with the inverted U-shape of Kuznets curve, with inflection point occurring when average per capita GDP reaches ¥31330.93 (calculated at comparable price of 1999). On the basis of analysis, it is suggested that the government, with a view to developing economy alongside protecting cultivated land, should attach more importance to land use and planning in the future, pay more attention to the spatial correlation of cultivated land planning in adjacent areas and make greater efforts to increase the input–output ratio of land.

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1. Literature review

With the rapid development of economy, and the acceleration of urbanization and industrialization, cultivated land, as a rare resource in China, is facing severe risks. The area of cultivated land is decreasing substantially, with large amount being converted into construction land. It has been pointed out by Zheng et al., 2013 that once the cultivated land stocks fall blow a threshold value, food security problems will arise and hinder the sustainable development of economy. In the background of increasingly acute conflict between cultivated land protection and economic development, how to balance cultivated land protection and economic development, has become an issue requiring utmost attention from government and academic circles.

Many researches have been conducted on the conflict between economic growth and cultivated land conversion. Chen and Long (2007) attempted to seek a long-term equilibrium between economic growth and cultivated land conversion from a co-integration perspective. Their studies confirmed a positive correlation between the decrease of cultivated land and economic growth. More researchers, at home or abroad, analyzed the effect of economic growth on cultivated land conversion through Kuznets curve. Kumar and Aggarwal (2003) used fixed effect model and random effect model to analyze the panel data of 19 states across India. The results showed that the relationship between the decrease of cultivated land and per capita income agreed with the inverted shaped Kuznets curve, with the inflection point occurring when per capita income reaches 1347–1440 Indian Rupee (at a comparable price of 1963). Similarly, Cai and Zhang (2005), through selecting the time serial data of Shenzhen, Dongguan, Wuxi, Wuhan, and Shanghai for analysis, confirmed the existence of Kuznets curve of cultivated land, too. The inflection points calculated at current year's price are different for five cities, ¥12707 for Shenzhen, ¥8360 for Dongguan, ¥17751 for Wuxi, ¥5192 for Wuhan, and ¥11700 for Shanghai. He et al. (2008) verified through OLS method that the relationship between the decrease of cultivated land in China from 1986 to 2004, and economic growth is in agreement with the Kuznets curve, with the inflection point occurring when per capita income reaches ¥1991.61 (at the price of 1978). Liu et al. (2008) found, through using the provincial data

* Corresponding author. Tel.: +86 13971098589; fax: +86 27 88665616.
E-mail address: gqbhust@aliyun.com (Q. Guo).

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from 1987 to 2005 for analysis, found that the relationship between economic growth and cultivated land conversion took a U-shaped curve, with the inflection point occurring when per capita GDP reaches ¥16002.42 (at the price of 1986). According to Tang and Wei (2011), the inflection point occurs when per capita GDP reaches ¥2547.16 (at the price of 1978). However, there is another group of researchers, represented by Hu and Shi (2008), Li and Zhao (2011), Wang and Xu (2012) who contended that the relationship between economic growth and the decrease of cultivated land do not agree with the Kuznets curve.

From the above literature, it can be seen that the consensus has not been reached on whether, the relationship between economic growth and cultivated land conversion agrees with the Kuznets curve, and that amid large amount of researches which use time serial data or panel data from different geographic regions or administrative regions to analyze the relationship between cultivated land conversion and economic growth, there are few statistics or description of spatial distribution. Conventional time serial analysis fail to take spatial characteristics into account, while, conventional panel data, though considering spatial characteristics, put more emphasis on spatial heterogeneity rather than spatial correlation. Anselin (1988) noted that nearly all the spatial data are spatial dependent or spatial auto-correlated. The existence of spatial auto-correlation will inevitably reduce the stability and accuracy of conventional time-serial data and panel data model, and impair their explanatory power to the extent that they are inadequate to reflect the reality.

In view of this, using the panel data at provincial level, the paper attempts to adopt the recently developed spatial panel model to empirically test whether the economic growth in China and cultivated land conversion conform to the inverted U-shaped Kuznets curve. With the improvement of the stability and accuracy of estimated results, the paper aims at drawing conclusion that better reflect the reality and providing reference, and suggestions for Chinese government in making decisions to reconcile economic development with preserving cultivated land, and to resolve the conflict between subsistence and construction.

2. Spatial model of Kuznets curve of cultivated land

2.1. Equation for Kuznets curve of cultivated land

In the Kuznets model of cultivated land, the explained variable is the decrease of cultivated land, the explanatory variable is the level of economic growth and its square, which is called as the quadratic equation of Kuznets curve of cultivated land. If the cube of economic growth level is added to the explanatory variable, the derived model is called the cubic equation model of Kuznets curve of cultivated land. Therefore, while treating the Kuznets model of cultivated land, it is preferable to choose quadratic equation. Only if the quadratic equation cannot provide desirable fitting we will use cubic equation model.

Let the estimation coefficient for the explanatory variable of economic growth level and for its square be $\beta 1$ and $\beta 2$, respectively, we have the following relation: ① if $\beta 1 = \beta 2 = 0$, it suggests that economic growth has no relation with cultivated land conversion; ② if $\beta 2 = 0$, $\beta 1 \neq 0$, it suggests that the area of converted cultivated land is in linear relationship with economic growth. ③ If $\beta 1 > 0$ and $\beta 2 < 0$, it suggests that cultivated land conversion is in inverse U-shaped relation with economic growth; ④ if $\beta 1 < 0$, $\beta 2 > 0$, it suggests that cultivated land conversion is in positive U-shaped relation with economic growth; ⑤ if $\beta 1 > 0$, $\beta 2 > 0$, it suggests that cultivated land conversion is in positive relation with economic growth, ⑥ while if $\beta 1 < 0$, $\beta 2 < 0$, it means that the area of cultivated land conversion is in negative relation with economic growth.

2.2. Setup for spatial model of cultivated land Kuznets curve

The paper uses spatial panel model to analyze the relationship between Chinese economic growth and cultivated land conversion. The main function of the spatial panel model is to overcome the effect of spatial auto-correlation in regression analysis. Due to the fact that spatial auto-correlation is mainly manifested in dependent variable and error term, resulting in the spatially lagged dependent variable and spatially lagged error term, spatial econometrics mainly have the following two models: spatially lagged model (SLM), and spatial error model (SEM).

In much the same way that conventional panel model can be divided into fixed effect model, and random effect model depending on the decomposition of error component, spatial panel model can be divided into spatial fixed effect model and spatial random effect model. Therefore, SLM and SEM can be divided into spatially lagged fixed effect model, spatially lagged random effect model, spatial error fixed effect model, and spatial error random effect model. Drawing on the common practice adopted by Elhorst (2003), and other researchers in empirical study of spatial panel model, the paper chooses spatial fixed effect model on the grounds that when carrying out regression analysis on particular subject, fixed effect model exhibits higher accuracy than random effect model. The setup for the fixed effect model of the quadratic equation of cultivated land Kuznets curve is as follows:

2.2.1. Spatially lagged fixed effect model

$$\mathrm{Ln}Y_{it} = \alpha i + \beta 1 \mathrm{Ln}X_{it+} \beta_2 (\mathrm{Ln}X_{it})^2 + \delta \sum_{j=1}^{n} W_{ij} \mathrm{Ln}Y_{jt} + \varepsilon_{it} \quad (1)$$

2.2.2. Spatial effort fixed effect model

$$\mathrm{Ln}Y_{it} = \alpha i + \beta 1 \mathrm{Ln}X_{it} + \beta 2 (\mathrm{Ln}X_{it})^2 + \varepsilon_{it} \quad (2)$$

In Models (1) and (2), i represents the region i, j represent other regions, t represents sampling years, n represents the number of regions, Y is the dependent variable – the decrease of cultivated land, X is the independent variable-the economic growth level, α is the constant term, $\beta 1$ and $\beta 2$ are the coefficients of independent variable, δ is the spatial auto-regression coefficient, λ is the spatially auto-correlation coefficient, ε and μ are the random error terms that obey normal distribution. Ln is the logarithm for each index taken to avoid heteroscedastic disturbance. W is the spatial weighted matrix, which reflects correlation between regions. In actual practice, spatial weighted matrix can not be generated from relevant data or model as conventional weighted matrix. In spatial econometrics, the neighbor relation is mainly measured in terms of adjacency and distance. The paper uses binary symmetry spatial weighted matrix, which can be obtained in the following steps: first set W_{ij}, if the region i is adjacent to region j, then W_{ij} is 1, otherwise W_{ij} is 0. Then normalize the spatial weighted matrix by using each element to divide the sum of all elements in a row to make the row sum of new matrix be 1.

2.3. Spatial correlation test and set of model

The spatial auto-correlation coefficient Moran's I is used to test whether spatial correlation exists between regions variables, the value range of which is $(-1, 1)$. If Morans $I > 0$, it means that some economic variable exhibits spatial positive correlation between regions, and the larger the value is, the stronger the correlation will be. Inversely, if Moran's $I < 0$, spatial negative correlation exists. If

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