Journal of Applied Science and Engineering Innovation, Vol.3 No.6, 2016, pp. 209-212
ISSN (Print): 2331-9062
ISSN (Online): 2331-9070

Application of Decoupling Theory in Land Resources System and It's a New Model

Xu Yu-hong[1,2], Zhao Xiao-fan[1]

[1]*College of Management, Shenyang Normal University, Liaoning, Shenyang, 110034, China.*
[2] *Bureau of Land Resources in Panjin City, Liaoning, Panjin, 124000, China.*

Abstract*:* The key scientific issue about relationship between land use change and economic growth has been explored based on decoupling theory perspective in the study. Decoupling theory and decoupling analysis have been introduced to analyzed relationship between land use change and economic growth. Decoupling definition of land-use change and economic growth has been explained, decoupling evaluation method which based on the elastic analysis has been improved and decoupling analysis model of land-use change and economic growth has been established. In the paper, we analyzed the application of decoupling theory in land resources system in home and abroad, and building a new model for illustrating its new application. The new model was individed into four categories, including positive coupling, positive decoupling, negative coupling and negative decoupling, which were further subdivided into strong coupling, weak coupling, weak decoupling, strong decoupling, strong negative coupling, weak negative coupling, weak negative decoupling, and strong negative decoupling.

Keywords. Application of decoupling theory, Decoupling method and model, Land use system

INTRODUCTION

Decoupling, which derived from physics areas, indicates that the interrelation between two or more physicals, which takes on responsive relationship, were not exists. In the area of resources and environment, decoupling as one kind of tools is used to measure the pressure state between economic development and the consumption of materials and the ecological environment, and to weight the sustainability of economic development model.

There were many kinds of methods of decoupling evaluation, for instance, comprehensive analysis of variation, decoupling index method, elastic analysis method, decoupled analysis method based on the complete decomposition technique, IPAT model method, descriptive statistics analysis method, econometric analysis method, differential regression coefficient method and so on. Different research methods, which were based on different research perspectives and specific regional practice, had their own advantages and disadvantages in practice.

From the summary of foreign and domestic research status, we can concluded that the main research of decoupling analysis in the field of land resource management just include decoupling analysis between occupation of cultivated land and economic growth and decoupling analysis between expansion of construction land and economic growth[1]. While in the research of decoupling analysis between expansion of construction land and economic growth, rural area construction land and city construction land were not distinguished and was viewed as entirety. From this point of view, this paper get rid of the rural area construction land, which included in the construction land, and major research is focus on decoupling analysis between city construction land and economic growth. To some extent, this paper is more accurate reveal the decoupling conditions between city construction land and economic growth.

APPLICATION OF DECOUPLING IN FOREIGN LAND MANAGEMENT

Decoupling theory was first proposed by Weizsacker and Schmidt-Bleek of the Wuppertal Institute in Germany. They advanced the goal of decoupling of global and developed country separately in the late 20th century, which was called "quadruple revolution" and "ten multiple revolution", that was to say the efficiency of resource use of global and developed country should improved four times and ten times separately within fifty years, in order to achieve the goal of decoupling between the resource consumption and economic development.

Soon afterwards, decoupling theory has been widely used in the relative research field of economic development. To explore how to block the correlation between the quality of the environment damage and economic development, Organization for Economic Co-operation and Development (OECD) established a suite of indicators system in the report of "Indicators to Measure Decoupling of Environmental Pressure from Economic Growth" in 2002, which

was based on the level of the driving force - pressure on the environment - state of the environment, so as to measure the decoupling state between economic development and the consumption of materials and the ecological environment pressure, and conducted decoupling analysis of 39 indicators of environment and economic, and further posed the conception of relative decoupling and absolute decoupling[2].

In 2003, Juknys termed the decoupling between the use of natural resources and economic growth as primary decoupling, and called the decoupling of environmental pollution and natural resources as secondary decoupling. At the same time, Juknys also analyzed the decoupling situation of Lithuania. In the same year, Herry Consult GmbH conducted decoupling analysis of economic growth and transport demand situation of Austria. Petri Tapio introduced the conception of elasticity and constructed decoupling indicators in 2005, when he studied the decoupling level of Europe's transport sector energy and carbon dioxide between the years of 1970-2001.

Furthermore, Tapio advanced the conception of "decoupling elasticity" and subdivided the decoupling indicators into link, decoupling and negative decoupling. Then Tapio further broke down the decoupling indicators into eight categories, including weak decoupling, strong decoupling, week negative decoupling, strong negative decoupling, expansive negative decoupling, expansive linking, recessive decoupling and recessive linking, and perfected the system of decoupling indicators[3]. In 2006, David Gray, Jillian Anable, Laura Illingworth and Wendy Graham conducted a study of decoupling situation between economic growth and traffic volume and carbon dioxide emission of Scotland.

At present, there were two kind of the decoupling evaluation modes of the Western mainstream: (1) relationship research between material consumption amount of total and economic growth, which referred to make a comparative study of the relationship between the change direction and extent of economic aggregate and the change of total material consumption at the same time, it meant decoupling in the sense of scale of material consumption or the so-called absolute dematerialization, such as in pace with economic growth, the total energy consumption, total consumption of water resources , total consumption of construction land and the main pollutant emissions tended to stable or reduce. (2) Research of IU curve for material consumption intensity, which meant conduct a comparative study of the change relationship of intensity of substance use, it referred to decoupling in the sense of use efficiency of substance or the so-called relative dematerialization. For instance, in pace with economic growth, the energy consumption, water consumption and pollution emission of per 10,000 Yuan of GDP tended to continued decrease.

APPLICATION OF DECOUPLING IN DOMESTIC LAND MANAGEMENT

Currently, there was less research literature with regard to decoupling, which mainly concentrated in the decoupling relation analysis between regional economic growth and pressure on resources and environment. It included many respects, such as energy consumption (electricity, water), oasis decoupling analysis, loss of geological disasters, environment pressure (pollutants emissions) and so on.

In addition to the decoupling relation analysis between pressure on resources and environment (energy consumption, pollutants emissions, geological hazards, etc.) and economic growth, the decoupling theory was also applied to the field of land resources management. It mainly includes:

(1) Decoupling analysis between occupation of cultivated land and economic growth

Chen Baiming and Du Hongliang conducted a decoupling research on occupation of cultivated land in and GDP growth of China by using the decoupling theory and analysis methods in 2006. In 2007, Cao Yingui, Cheng Ye and Chun Yuan applied the decoupling theory and lead to the decoupling index to analyzed the relationship between the change of cultivated land and GDP of different regions, at the time they also established the correlation between the amount of cultivated land of the different area and socio-economic indicators, and framed a regression curve of the arable land and GDP by using the methods of correlation analysis and regression analysis. Based on decoupling theory, Yang ke, Chen Baiming and Song Wei analyzed the decoupling state and the reasons of the occupation of cultivated land and GDP growth of various stages of Hebei in 2009 province by using calculation model of decoupling index which proposed by Economic Cooperation and Development and decoupling state divided by Tapio, by building decoupling model, by calculating decoupling flexibility, and by establishing the plot of decoupling degree. Song Wei, Chen Baiming and Chen Xiwei analyzed decoupling mechanism and causality between occupation of cultivated land and economic growth in 2009 by making use of interrelated data of construction land occupy cultivated land of Chanshu city during the year1985 to 2005[4]. In 2010, Feng Yanfen and Wang fang (2010) calculated the decoupling relationship between cultivated land consumption and the economic growth of Guangzhou during the year1996 to 2002 by using decoupling evaluation model of total comparison method and by designing decoupling index and decoupling rate of cultivated land consumption and the total amount of the economic growth.

(2) Decoupling analysis between expansion of construction land and economic growth

Guo Lin and Yan Jinming investigated the decoupling relationships of construction land occupy cultivated land and economic growth by using the method of decoupling research, then they generalized the characteristic of spatial distribution and evaluated the enforcement effects of the stringent conservation policy of cultivated land of China in 2007. In 2008, Li Xiaoshun, Qu Futian and Guo Zhongjing injected basic theory and method into the field of land management and proposed the decoupling situation of city and countryside construction land of China. After that, they also distinguished eight conditions of decoupling degree, selected the assess indicators, and executed demonstration analysis of variation relationships of city and countryside construction land of Lingang new city based on computing marginal value and establishing analysis model of decoupling. Hu Zhichao, Zou Jian and Long Hualou analyzed space-time configuration of expansion of construction and variation of GDP of secondary industry and tertiary industry during the year 1999 to 2006 of China by taking advantage of elasticity coefficient of decoupling in 2010[6]. Zhong Taiyang, Huang Xianjin led decoupling conception and decoupling analysis of the environment field into the field of land use in 2010, and framed the decoupling analysis method of expansion of construction land and economic growth. Based on evaluate model of decoupling theory, Yang Lujia, Li Jianqiang and Mei Weiwei analyzed the interrelation between expansion of construction land and economic growth in 2011.

BUDING A NEW MODEL FOR APPLICATION OF DECOUPLING

There were many models to consider the decoupling trajectory of land use and GDP growth, such as decoupling index method, elastic analysis method, differential regression coefficient method and decoupling analysis method based on complete decomposition technique. Considering the research needs of this project, the project referred to the elastic analysis method proposed by Tapio in 2005 to improve the “ground consumption” coefficient of unit GDP. Its formula was:

$$D_i=\frac{\Delta LUC\Big/\left[n\times\left(LU_{i_{initial}}+LU_{i_{end}}\right)\Big/2\right]}{\Delta GDP\Big/\left[\left(n\times\left(GDP_{initial}+GDP_{initial}\right)\right)\Big/2\right]}=\frac{(LU_{i_{initial}}-LU_{i_{initial}})\Big/\left[n\times\left(LU_{i_{initial}}+LU_{i_{end}}\right)\Big/2\right]}{(GDP_{end}-GDP_{initial})\Big/\left[\left(n\times\left(GDP_{initial}+GDP_{end}\right)\right)\Big/2\right]} \quad (1)$$

In the formula, D_i is the consumption coefficient of the class i of land resource, $LU_{i_{end}}$ and $LU_{i_{end}}$ are respectively the area at the end of and the beginning of study of the class i of land resource and the early research on land resources; at the end of GDP and the beginning of GDP are respectively the area GDP at the end of and the beginning of study; ⊿LUC、⊿GDP are respectively land use change and the growth rate of GDP; n is the study period, if the next year, n=1.

According to the regional land use change and GDP growth data, using the formula, from the perspective of time and space dimensions, the project respectively studied whether decouple between land use change (⊿LUC) and GDP growth rate (⊿GDP) from area annual series and space series. The consumption coefficient and decoupling judgment come down in one continuous line; the higher consumption coefficient is, the stronger their dependence is and the lower degree of decoupling is.

According to the research needs of this project, the judgment criterion of decoupling degree is shown in figure 1.

When in the first quadrant, ⊿GDP ＞ 0, ⊿LUC＞0, GDP growth at the same time, the area of land use is also increasing, which shows that the two are in the positive coupling phase. Among them, when 0 < Di < 1, the two are in the weak coupling condition; when Di ⩾ 1, the two are in the strong coupling condition. When in the second quadrant, ⊿GDP＞0，⊿LUC＜0, GDP growth, but the land use area is reduced, which shows that the two are in the positive decoupling phase. Among them, when 0 ＞ Di⩾-1, the two are in the weak decoupling state; when Di < -1, the two are in the strong decoupling state, and it is the most ideal state. When in the third quadrant, ⊿GDP＜0, ⊿LUC ＜0, GDP reduction, the area of land use is also reduced, which shows that the two are in negative phase coupling. Among them, when 0 < Di < 1, the two are in the weak negative coupling state; when Di ⩾ 1, the two are in the strong negative coupling condition. When in the fourth quadrant, Delta ⊿GDP＜0, ⊿LUC＞0, GDP reduction, but the area of land has increased, which shows that the two are in a negative decoupling state. Among them, when 0 < Di < -1, two for the weak negative decoupling state; when the Di is greater than or equal to -1, the two are in the strong negative decoupling state. This is the most unsatisfactory state.

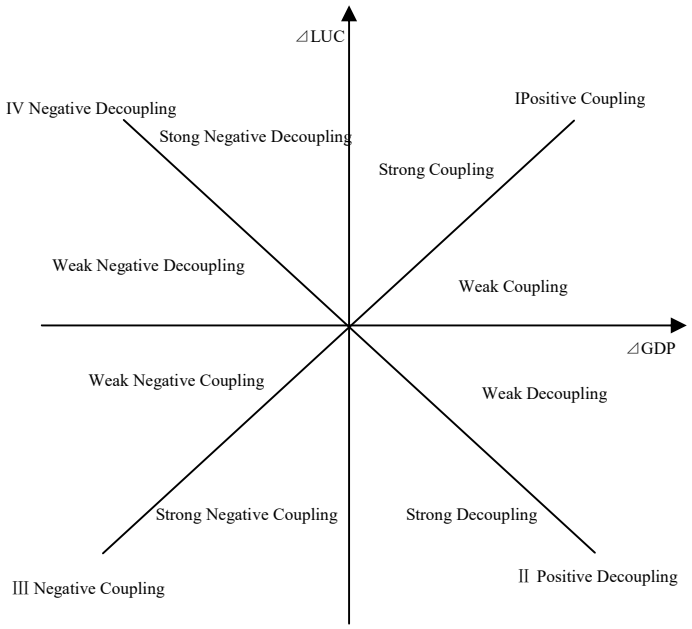

Figure. 1 Coupling and decoupling of land use change and GDP growth

CONCLUSIONS

1) Decoupling theory has been used widely in the field of resources, environment and ecology. In the paper, we illustrated the application of decoupling theory in land resources system in home and abroad, where dometic application was explained from decoupling analysis between occupation of cultivated land and economic growth, and decoupling analysis between expansion of construction land and economic growth.

2) We built a new model for illustrating its new application. The new model was individed into four categories, including positive coupling, positive decoupling, negative coupling and negative decoupling, which were further subdivided into strong coupling, weak coupling, weak decoupling, strong decoupling, strong negative coupling, weak negative coupling, weak negative decoupling, and strong negative decoupling.

ACKNOWLEDGMENT

The financial support received from Major Project of Social and economic development from Federation of Social Science in Liaoning Province of China (2017lslktzd-018), Social science planning fund project in Liaoning province of China (L15BGL026), Project of "Regional development and management" base from Federation of Social Science in Liaoning Province of China (2016lslktglx-12), and the Outstanding scientific and technological personnel support plan in Chinese Shenyang Normal University (201403).

REFERENCES

Ayres R U, Ayres L W, Warr B. Energy, Power and Work in the US Economy, 1900-1998 [J]. Energy, 2003, 28(3): 219-273.

De Bruyn SM, Opschoor JB. Developments in the throughput-income relationship: Theoretical and empirical observations [J].Ecological Economics, 1997, 20(3): 255-268.

Diakoulaki D, Mandaraka M. Decomposition analysis for assessing the progress in decoupling industrial growth from CO2 emissions in the EU manufacturing sector [J]. Energy Economics, 2007, 29(4): 636-664.

Guo Junting, Zhang Zhiqiang, Zhou, Jie, et al. Decoupling cultivated land loss by construction occupation from economic growth in Beijing [J]. Journal of the American Water Resources Association, 2014, 50(6): 1425-1438.

Song W. Decoupling cultivated land loss by construction occupation from economic growth in Beijing [J]. Habitat International, 2014, 43(3): 198-205.

Tapio P. Towards a theory of decoupling: Degrees of decoupling in the EU and the case of road traffic in Finland between 1970 and 2001[J]. Transport Policy, 2005, 12(2): 137-151.