The Coupling Analysis between Forestry Industry and Regional Economy in Yunnan China Based On the Spatial-Time Data

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Abstract. As the forestry industry is the important impetus to promote the sustainable development of regional economy, it is worthwhile to measure the degree of "toughness" between forestry industry and regional economy. To explore the coordination of the two in Yunnan China, the study constructs the evaluation index system and applies the coupling coordination model, then acquire some of enlightenment. The empirical results showed that the level of coordination between forestry industry and regional economy was improving continuously during 2000 to 2014, and the situation was optimized from serious imbalance to primary coordination. Interestingly, these results change significantly when different models are considered. Although the analysis is purely experimental studies in research, the results are sufficiently clear to suggest that forestry industry and regional economy is relevant closely. This indicates that there is still much space for the development of forestry industry in Yunnan China.

Introduction

With the concept of sustainable development rooted into heart [1], the Chinese government paid more attention on the balance between ecological environment and economic development, issued policies to emphasize the importance and urgency of ecological civilization construction. In the construction of ecological civilization, forestry is in the basic and forefront position, playing a key and leading role, with dual mission to optimize the ecological environment and promote economy development. Meanwhile, the forestry industry is the basic and link to achieve the harmony between man and nature, and is the carrier and platform to promote the construction of ecological civilization [2]. The forestry industry not only is the important impetus to promote the sustainable development of regional economy, but also is the significant driving force to improve the traditional industries, to enhance the competitive industries, to cultivate emerging industries [3].

Many studies had shown that there are closely linked between the potential productivity of specific industries and the level of regional economy. Some factors, such as regional land, regional trade and regional structure etc. have determined a specific industry which effect on regional input-output relationship, hence it form the "toughness" of regional economic structure [4][5][6]. With other words, this particular industry is making an important contribution to the growth of regional economy during a long time, for instance, manufacturing and processing industry has ever been a pillar industry in the Pearl River Delta region in China. However, high-tech industry and modern service industry are becoming alternative pillar industries. In order to study quantitatively the toughness between the two, scholars had developed a variety of models, such as input-output model, gray correlation model, chaotic model and coupling model. Among these models, coupling is a physical conception and its model has applied widely to study the close interaction with each other in two or more systems. Steinberger et al. studied the degree of tightness between state-owned enterprises and regional economy in 12 countries during 1970-2004 [7]. It is found that the

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state-owned enterprises in these countries have a strong technology spillover effect and a significant cohesion for regional economy development. Based on the United Nations COMTRADE database, Dittrich et al. studied the degree of relativity between economy development patterns and ecological environment in different countries [8]. It shows that emerging economies have higher per capita consumption of resources and lower efficiency of resource use than developed economies. Ying Huo measured the coupling development efficiency between strategic emerging industry cluster and regional economy space based on coupling model in China [6]. The results show that the coupling development efficiency decreases from east to middle and west. Only 6 provinces in the eastern coastal areas of strategic emerging industry cluster are ahead of regional economy development, but most of the provinces are lagging behind. Nie M used the coupling model to evaluate the coordination development between logistics and regional economy. The study shows that the development level of regional logistics is quite different, showing a gradual distribution gradient from east to west [9]. The logistics and regional economy in the eastern region belongs to the coordination region, while the central and western regions are in the state of imbalance. Linghua Ding and Qiannan Zhang analyze the coupling and coordination relationship between modern information service industry and regional economy in Guangdong province by the coupling coordination model. The research indicates that the development of modern information service industry lags behind of the regional economy in Guangdong province, and it is in the stage of primary coupling and coordination [10]. Gaojie Wang uses the AHP-EVM combination weighting method and the coupling coordination model to analyzes the evolution process of the financial and regional economy coupling and coordination in the Bohai Sea region. And put forward some policy suggestions to promote the coordination development of financial and regional economy in Bohai Rim Region [11]. According to the studies, the coupling model has strong maneuverability, and the conclusions are in line with the actual situation.

This article will exert the coupling model to evaluate quantitatively the coordination level between forestry industry and regional economy, analyzing the impact degree that forestry industry work on regional economy development in Yunnan China, providing evidence to make policy for the construction of forestry.

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Evaluation index system.

In order to achieve the expected research objectives, the authors establish the evaluation index system between the two subjects see table 1.The evaluation index is divided into two categories: the forestry industry index and the regional economy index.

The forestry industry index reflects the development level of forestry industry [12]. There are five first-level indexes: forestry resource endowment reflects the sustainable development capacity of forestry, which is expressed by the size of woodland area and forest area. The scale of forestry industry refers to the value of various products and services produced by the forestry industry in a certain period of time, usually measured by the gross output of forestry industry and the proportion of forestry industry in GDP. The structure of forestry industry intends the proportions of various sectors within the three industries of forestry. The benefits of forestry industry are divided into economic [13], social and ecological benefits, represented by the contribution rate of forestry industry, employees of forestry system, annual average wage of forestry systems employees, wetland area, and forest coverage. The development environment of forestry industry means the government attaches importance to the development of forestry industry through formulating relevant policies.

The regional economy index reflects the development situation of regional economy. There are five first-level indicators: the scale of economy reflects the level of regional economy development, set the regional GDP, total retail sales of social consumer goods, local fiscal revenue and the total value of import and export [14]. The structure of economy refers to interactive efficiency between industrial structure and economy structure, indicated by the proportion of the three industries accounted to the total output value respectively.

Table 1 the index of coupling evaluation system between forestry industry and regional economy

Element Layer	First-Level Indicator	Second- Level Indicator	Weight
Forestry Industry	Forestry Resource Endowment	Woodland Area	0.027
		Forest Area	0.030
	Scale Of Forestry Industry	Total Output Value Of Forestry	0.039
		The Proportion Of Total Forestry Output In GDP	0.028
	Forestry Industrial Structure	The Proportion Of First Forestry Industry Output In Total Forestry Output Value	0.027
		The Proportion Of Second Forestry Industry Output In Total Forestry Output Value	0.031
		The Proportion Of Third Forestry Industry Output In Total Forestry Output Value	0.028
	Benefits Of Forestry Industry	Contribution Rate Of Forestry Industry	0.038
		Forestry System Employees	0.032
		Average Annual Salary Of Forestry Employees	0.027
		Wetland Area	0.030
		Forest Cover Rate	0.028
	Forestry Industry Development Environment	Investment In Fixed Forestry Assets	0.052
		Utilization Of Foreign Capital In Forestry	0.037
		Investment In Forestry Education	0.032
Regional Economy	Economy Scale	GDP	0.040
		The Total Retail Sales Of Social Consumer Goods	0.036
		Local Fiscal Revenue	0.038
		Total Value Of Import And Export	0.034
	Economic Structure	The Proportion Of First Industry In GDP	0.025
		The Proportion Of Second Industry In GDP	0.029
		The Proportion Of Third Industry In GDP	0.027
	Economic Benefits	Labor Productivity	0.032
		Net Income Per Capita Of Urban And Rural Residents	0.031
		Average Wages Of Employees	0.032
	Economic Openness	Dependence On Foreign Trade	0.028
		Actual Utilization Of Foreign Investment	0.040
	Economic Development Environment	Investment In Fixed Assets	0.047
		Number Of Regular Higher Education Graduates	0.034
		R & D Expenditure	0.040

The benefits of economy means the operating results achieved with equal labor costs, expressed in terms of labor productivity, net income per capita of urban and rural residents, and the average wage of employees. The openness of economy measures the openness degree of market economy. The development environment of economy means the environment created by the government for

the economy development, mainly depends on the physical capital and human capital [15]. Because each index has different dimensions and cannot be compared directly, so it is necessary to non-dimensional processing first. The author uses the standardized dimensionless to deal with the original data, and the weight of each index is determined by the entropy method.

Evaluation model.

Based on the concept of capacity coupling and the model of capacity coupling coefficient in physics, the coupling model of multiple correlative objects can be established. The formulation is:

$$c = \left\{ \left(u_1 \cdot u_2, \cdots, u_n \right) / \left[\prod \left(u_i + u_j \right) \right] \right\}^{\frac{1}{n}} \tag{1}$$

In the expression, c is the degree of coupling among several correlative objects, u_i is the evaluation index for the development level of each associated object. As it is only the forestry industry and regional economy in this research, reduce the dimension through the formula (1), the coupling model between the two is simplified as:

$$C = \left\{ \left(U_1 \cdot U_2 \right) / \left(U_1 + U_2 \right)^2 \right\}^{\frac{1}{2}} \tag{2}$$

$$U_1 = \sum_{i=1}^{m} a_i \cdot x_i \qquad U_2 = \sum_{j=1}^{n} b_j \cdot y_j \tag{3}$$

a_i and b_j is the weight of forestry industry and regional economy indicators respectively, and $\sum_{i=1}^{m} a_i = 1$, $\sum_{j=1}^{n} b_j = 1$. $x_i^{'}$ is the standardization indicators of forestry industry, $y_j^{'}$ is the standardization indicators of regional economy. U_1 and U_2 is the evaluation index of the two subjects respectively, C is the coupling degree between the two subjects.

The coupling degree can only explain the interaction intensity between the two related objects, but cannot reflect the level of the coordination. The coupling coordination degree not only can measure the coordination, but also can truly reflect the degree of coordination. Therefore, according to the actual development level and the contribution of forestry industry to the aggregate regional economy, the coupling coordination degree model is constructed:

$$T = \alpha U_1 + \beta U_2 \tag{4}$$

$$D = \sqrt{C \cdot T} \tag{5}$$

In the formulations, T is the comprehensive evaluation index between forestry industry and regional economy. D indicates the degree of coupling coordination. The smaller the value of coupling coordination degree is, the smaller the correlation between the two systems is, developing into disorder. The larger the value of coupling coordination degree is, the larger the correlation between the two systems is, developing into harmonious and orderly. α and β is the undetermined coefficient. Considering the mutual influence and promotion of forestry industry and regional economy, but forestry industry is only one part of regional industry, so it gives α =0.4, β =0.6.

Empirical analysis.

From China Forestry Statistical Yearbook 2014 and China Yunnan Statistical Yearbook 2015, the research data was obtained through preliminary calculation and collection for coupling evaluation between forestry industry and regional economy in Yunnan China.

By formulation (2) and (3) in the coupling model, the evaluation index of forestry industry development level U_1 and the evaluation index of regional economy development level U_2 and the coupling degree of the two C are calculated respectively. Moreover, it can get the comprehensive evaluation index T by equation (4). According to the formula (5), it can measure

the coupling coordination degree between forestry industry and regional economy D in Yunnan China. Seen Figure 1 can obtain the following implications:

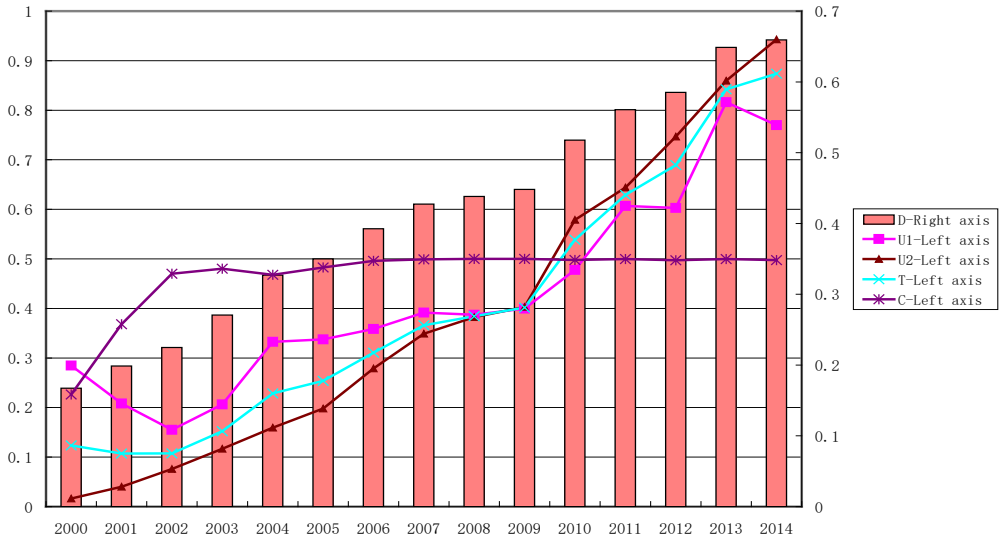

Fig.1 Coupling Evaluation Results Between Forestry Industry and Regional Economy in Yunnan

Firstly, the index of forestry industry development level U_1 in Yunnan had up and down tendency in the evaluation period. It declined from 2000-2002, uplifted slowly from 2003 to 2007, declined slightly in 2008 by the impact of the global financial crisis, demonstrated a significant growth trend in 2009-2013, and declined again in 2014. The frequent fluctuation is mainly due to the large volatility of forest area, forestry investment and the decrease of forestry workers.

Secondly, the index of regional economy development level U_2 in Yunnan had sign that it was a gradual growth trend in the whole evaluation period. It grew slowly during 2000-2009, then accelerated significantly since 2010, for the reason that the introduction of the "bridgehead" strategy and economy recovery policy launched by the central and local government, which had brought opportunities for the infrastructure construction and regional economy development in Yunnan.

Thirdly, the coupling degree between forestry industry and regional economy C in Yunnan was in the range of 0.23-0.5. It was the lowest value in 2000, and was a watershed in 2002, the coupling degree showed a slight fluctuation around 0.5 from this year. Due to the fluctuation of the forestry industry development in Yunnan, while the development of regional economy had been steadily improved, the coupling degree was stable and in constantly optimization.

Fourthly, under the common impact of forestry industry and the regional economy development in Yunnan, the evaluation index T grew steadily, especially boosted rapidly since 2009.

Fifthly, the coupling coordination degree of the two D improved continuously, the value changed from 0.1674 in 2000 to 0.6593 in 2014, and the coordination type changed from imbalance to primary coordination. It is divided into three stages: the coupling coordination degree was between 0.1 and 0.5 in 2000-2009, which belonged to the stage of imbalance stage. In this stage, the development of forestry industry dominated the coordination relationship between the two subjects. That was to say, the development pace of forestry industry exceeded that of regional economy, which had a strong driving force to the regional economy. However, the regional economy growth was too flat, which made it uncoordinated. The coupling coordination degree was between 0.5 and 0.6 in 2010-2012, which was a turning point during the whole study period, developing from imbalance to harmonious, and the coordination type entered into advanced trend. From 2013 to 2014, the coupling coordination degree was between 0.6 and 0.7, which was the primary coordination development stage. At this time, the regional economy development was faster than that of the forestry industry. The feedback effect of regional economy is stronger than the driving effect of forestry industry, so that lead to harmonious development.

Conclusion

In order to quantitatively analyze the toughness between forestry industry and regional economy in Yunnan China, the author designs a set of evaluation index system for the coupling coordination measurement of the two research objects. Through the collection of the original data and dimensionless, exert coupling model and coupling coordination model for empirical research.

(1)In the whole evaluation period, the index of forestry industry development level showed up and down tendency, while the regional economy development index demonstrated a gradual growth trend. It was a watershed between the two index lines in 2009. From 2000 to 2008, the development of the forestry industry grew faster than that of the regional economy. Because the forestry industry is only a part of the regional industry, the effect of forestry industry development is difficult to display when the growth of regional economy is flat. Once the development of regional economy grow faster than that of forestry industry since 2009, it is the time that the regional economy feeding back to the forestry industry.

(2)The coupling state of the two subjects was constant optimization and dynamic change when the coupling degree was in the range of 0.23-0.5. It was the lowest coupling degree in 2000-2001, the coupling level was weak and the contribution of forestry industry to regional economy was low. From 2002 to 2014, the coupling degree fluctuated around 0.5, the fluctuation range was small and stable relatively, which indicate that the forestry industry has grown obviously, but compared with other industries, it is still in “large resources, small industry, and poor efficiency”, so the total contribution to the regional economy is minor, and the coordination degree is lower.

(3)The coordination relationship between the two subjects was improving continuously, and the coupling coordination degree had been changed from 0.1674 in 2000 to 0.6593 in 2014. Meantime, the coupling type had been optimized from the serious imbalance to primary coordination. It belonged to serious imbalance in 2000, been on the verge of imbalance in 2009, got the primary coordination in 2014. It demonstrates that the status of forestry industry in the regional economy has been rapidly improved, and there is still much room for the development in the future.

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