Analysis and Evaluation of the Coupling Development between Arterial Industry and Venous Industry in Liaoning Province

Jiana Liu*, Yuting Huang

Nanchang Institute of Science and Technology, Nanchang, Jiangxi, China

Keywords: Arterial industry; Venous industry; coupling development

Abstract: At present, the environmental problem such as natural resources shortage and environmental pollution has not been alleviated. One of the important reasons is that the arterial industry and the venous industry do not form a benign coupling circulatory system. Arterial industry and venous industry are important components of circular economy. The benign and interactive development and coupling development between arterial industry and venous industry is an important guarantee to optimize our industrial structure, realize the resource environment and sustainable development of economy and society. Based on the evaluation model of the coupling coordination degree of arterial industry and venous industry, this paper takes Liaoning Province as an example to carry on the empirical research, and tries to provide reference for the coupling development of arterial industry and venous industry in other areas through empirical analysis. The analysis results show that the coupling relationship between arterial industry and venous industry in Liaoning is strong. The coupling development of the two industries has moved towards the primary coupling coordination stage, and has developed to a higher level.

1. Introduction

In recent years, the venous industry has received extensive attention as a strategic emerging industries. We should take appropriate measures to promote the coupling development of arterial industry and venous industry, and make the venous industry grow into a new economic growth point. And then, we can realize the aim of optimizing industrial structure and industrial upgrading and transformation. The development of venous industry is not to abandon the arterial industry. if not, will cause the arterial industry waste of resources, loss of the basis for the development of the vein industry. The coupling development of two industries is beneficial to realize the full utilization of all kinds of waste resources produced in arterial industry, on the other hand, it can provide basis for the development of venous industry. Therefore, the coupling development of arterial industry and venous industry is the strategic choice of promoting the stable development of two industries and realizing the integration of resources, and also the important measures to realize sustainable development and promote the construction of ecological civilization. Bruvoll Annegrete(1998)systematically analyzed the influence of the implementation of mineral tax on arterial industry, venous industry and their relationship, and pointed out that a reasonable levy of mineral tax can reduce the pollutant emission from the arterial industry to a certain extent, and improve the efficiency of resource utilization in the vein industry[1]. Hawley J M(2006)used the recycling of waste fabric as the research object, and pointed out that the venous industry has the characteristics of low operation cost and high resource level[2]. The value maximization can be realized only in the coordinated development of each link of the venous industry and the arterial industry.

2. Construction of coupling development model

2.1 The definition of coupling

As a physical concept, "coupling" refers to the phenomenon that two or more systems or motion forms interact with each other through interaction. In recent years, it has been widely used in the study of the relationship between industries [3]. The key to the linkage of the two industries from

disorder to order lies in the interaction and synergy between industries which can be measured by the coupling coordination degree [4]. To sum up, the coupling between the arterial industry and the venous industry is an important manifestation of the interaction of two industries under the circular economy system.

2.2 Efficiency function

Because of the difference of quantity degree of each index is not public degree can increase the difficulty of comprehensive evaluation. This paper chooses the efficiency function method to do dimensionless and standardized processing of the original data.In this paper, $X_{ij}(i=1,2,...,n;\ j=1,2,...,m)$ is used to denote the original value of the j index of the year i, $x_{ij}(i=1,2,...,n;\ j=1,2,...,m)$ represents the value after normalization, α_{ij} and β_{ij} respectively represents the upper and lower values of the index[5]. The formula is as follows:

$$x_{ij}=\frac{X_{ij}-\beta_{ij}}{\alpha_{ij}-\beta_{ij}},\ \beta_{ij}<X_{ij}<\alpha_{ij} \quad \text{（Positive Efficacy Index）} \tag{1}$$

$$x_{ij}=\frac{\alpha_{ij}-X_{ij}}{\alpha_{ij}-\beta_{ij}},\ \beta_{ij}<X_{ij}<\alpha_{ij} \quad \text{（Negative Efficacy Index）} \tag{2}$$

When the system is composed of elements, the total contribution of system elements can be realized through integration. Based on this, this paper establishes efficiency function (refer with: Eq.3) between arterial industry and venous industry. u_1 represents the efficacy of the arterial industry. u_2 represents the efficacy of the venous industry. λ_{ij} denotes the weight of each variable, and satisfies the relationship (refer with: Eq.4).

$$u_i=\sum_{j=1}^{m}\lambda_{ij}x_{ij} \quad \text{(i=1,2)} \tag{3}$$

$$\sum_{j=1}^{m}\lambda_{ij}x_{ij}=1 \tag{4}$$

2.3 The weight determination of entropy value method

The weights of each index are determined by means of the Entropy value method which can reflect the utility value of the index information profoundly and avoid the interference of human's subjective consciousness [6]. The specific steps are as follows.

(1) Non-negative processing of data. Based on data normalization, data translation is needed to avoid the meaningless value when seeking entropy: $x_{ij}'=x_{ij}+1$

(2)Calculation of proportion in j index of the year i: $p_{ij}=x_{ij}'\Big/\sum_{i=1}^{n}x_{ij}'$

(3)Calculation the entropy value of j index: $e_j=(-1/\ln n)\times\sum_{i=1}^{n}p_{ij}\ln p_{ij}$

(4)Calculation the difference coefficient of j index: $g_j=1-e_j$

(5)Determination of weight of evaluation index: $\lambda_j=g_j\Big/\sum_{j=1}^{m}g_j$

2.4 Evaluation model and classification of coordination degree

In order to deeply analyze the coupling relationship between arterial industry and venous industry, and fully reflect the staggered, dynamic and unbalanced nature of industrial development, this paper introduces the coupling coordination degree model (refer with: Eq.5 and Eq.6). Based on the model of capacity coupling system in physics, the model can reflect the coupling development level of arterial industry and venous industry comprehensively and objectively.

$$C=\left\{(u_1\cdot u_2)/[\prod(u_1+u_2)]\right\}^{1/2} \qquad C\in[0,1] \tag{5}$$

$$D=\sqrt{C*T} \tag{6}$$

$$T=au_1+bu_2 \tag{7}$$

In the formula, D is the coupling coordination degree, which indicates the coupling degree between the arterial industry and the venous industry; C is the coupling degree; T is the development of harmonized index, which reflects the overall synergy or contribution of the two industries; a and b are undetermined coefficient (according to the arterial industry and the venous industry in China's actual situation, a=0.2,b= 0.8).

Based on the coupling theory and the specific situation of the coupling development of arterial industry and venous industry, this paper analyzes the coupling degree and coupling degree of two industries in detail, and then determines 4 development states and 10 types of coupling coordination, as shown in table 1.

Table 1. Standard for the Division of Coordination degree between arterial industry and venous industry

Coupling development State	Coordinated development type	Coupling Coordination Degree
Good development (Coupling type)	Extremely coupling coordination	$0.9\leq D<1$
	High quality coupling coordination	$0.8\leq D<0.9$
	Good coupling coordination	$0.7\leq D<0.8$
Medium-scale development (Harmonic type)	Intermediate coupling coordination	$0.6\leq D<0.7$
	Primary coupling coordination	$0.5\leq D<0.6$
Initial development (Misalignment type)	Reconciliation of coordination	$0.4\leq D<0.5$
	Barely coordinated	$0.3\leq D<0.4$
Budding development (Contradictory type)	Mild uncoordinated	$0.2\leq D<0.3$
	Serious uncoordinated	$0.1\leq D<0.2$
	Extremely uncoordinated	$0\leq D<0.1$

3. Empirical Analysis：Taking Liaoning Province as an Example

3.1 The construction of index system

The catalogue scope of the vein industry in the emerging technology industry. The coupling development between the vein industry and the arterial industry can be likened to the coupling development between the emerging technology industry and the traditional industry. In this paper, the indexes of arterial industry and venous industry are selected by using the coupling and coordinated development index between industries. Combined with the reference to the relevant academic achievements and the correlation industry coupling theory, this paper chooses 8 corresponding indices from three aspects of economic development, social progress and sustainable development, as shown in table 2.

Table 2. The coordinate development index system of arterial industry and venous industry coupling

Venous Industry	Symbol		Arterial Industry	Symbol
Ratio of assets to liabilities(%)	M_{11}	Economic benefits	Ratio of assets to liabilities(%)	N_{11}
Total asset contribution rate(%)	M_{12}		Total asset contribution rate(%)	N_{12}
Cost-cost rate(%)	M_{13}		Cost-cost rate(%)	N_{13}
The amount of garbage in the household(Million tons)	M_{21}	Social contribution	The proportion of regional industrial output value to total region output value(%)	N_{21}
The harmless treatment rate of domestic waste(%)	M_{22}		Proportion of industrial employed population to total employed population(%)	N_{22}
Product Sales Rate(%)	M_{31}	Development potential	Product Sales Rate(%)	N_{31}
Investment in environmental pollution control(Billion Yuan)	M_{32}		R&D funds expenditure(Billion Yuan)	N_{32}
Comprehensive utilization of industrial solid wastes(%)	M_{33}		The proportion of R&D expenses to main business income(%)	N_{33}

3.2 Data source and Weight determination

In order to reflect the trend of coupling development between arterial industry and venous industry clearly, this paper collects the relevant data from 2005-2016 of Liaoning province for empirical analysis. The related data of arterial industry and venous Industry Index system are all derived from the Statistical Yearbook of China and the Statistical Yearbook of Liaoning Province. Based on the original data, this paper chooses the entropy method to calculate the weights of each index. The weight of the evaluation index is calculated as shown in table 3.

Table 3. Weight of each evaluation index

Venous Industry	Weight	Arterial Industry	Weight
M_{11}	0.0934	N_{11}	0.0897
M_{12}	0.1096	N_{12}	0.1728
M_{13}	0.0911	N_{13}	0.1296
M_{21}	0.1696	N_{21}	0.0971
M_{22}	0.1613	N_{22}	0.0843
M_{31}	0.0974	N_{31}	0.1116
M_{32}	0.1256	N_{32}	0.1884
M_{33}	0.1519	N_{33}	0.1263

3.3 Coupling development evaluation

3.3.1 Empirical results

Combining arterial industry and venous industry coupled coordination degree evaluation model, relevant actual data and index weight, This paper calculates the integrated sequence parameter u_1 and u_2 of the coupling interaction between arterial industry and vein industry in Liaoning Province and their coupling coordination degree D. The results are as shown in table 4.

Table 4 Evaluation of coupling development of arterial industry and venous industry in Liaoning Province

Year	u_1	u_2	D	Coordinated development type
2005	0.3885	0.2736	0.3821	
2006	0.2660	0.3055	0.3853	Barely coordinated
2007	0.2646	0.2951	0.3798	
2008	0.2348	0.2687	0.3615	
2009	0.3179	0.4073	0.4396	
2010	0.4702	0.4040	0.4561	Reconciliation of coordination
2011	0.4106	0.4958	0.4882	
2012	0.4937	0.7369	0.5808	
2013	0.4050	0.7308	0.5647	Primary coupling coordination
2014	0.5251	0.6569	0.5597	
2015				Intermediate coupling
	0.5655	0.7753	0.6018	coordination
2016	0.5379	0.5594	0.5268	Primary coupling coordination

3.3.2 Result analysis

The results of u_1 and u_2 in Table 4 show that the development of arterial industry and venous industry in Liaoning Province is on the rise. According to u_1, we can draw a conclusion that the venous industry in Liaoning Province is in a slow development period in 2005-2012. The development of the venous industry in this stage is not yet stable; In the past 2012-2016 years, the pace of development has tended to be stable and steady upward trend. At this stage, the development of venous industry in Liaoning Province has gradually become a long-term transition. According to u_2, we can draw a conclusion that the arterial industry of Liaoning Province has been developing at a rapid speed over the past 2005-2012 years. In recent years, the State has vigorously advocated sustainable development, which limits the development of arterial industry in Liaoning province to some extent. After 2013, the development of arterial industry in Liaoning province slowed down, and there was a downward trend. Especially in 2016, the value of synthetic creep decreased to 0.5594. The arterial industry must take the road of new industrialization and seek a new development path. The difference of the starting time, the development scale and the development state of the two industries determines that the arterial industry has been developing at a higher level than that of the venous industry. In recent years, the change of environmental policy, government tendency and other factors have caused the arterial industry to face the bottleneck of development, but it has brought great development opportunity to the vein industry. Only by promoting the coupling and coordinated development of the two can we break the deadlock of arterial industry and accelerate the development of venous industry.

The results of u_1 and u_2 in Table 4 show that the coupling coordination degree of arteriovenous industry in Liaoning Province increased in the 2005-2016. It shows that the coupling degree of the two industries has been deepened. The coupling development phase of the two industries is a barely coordinated phase in 2005-2008, and is a harmonious coordination phase in 2009-2011, and is primary coupling coordination phase after 2011. The coupling development of two industries basically realizes the intermediate coupling coordination in 2013, but it's not yet stable. In the next few years, we should adopt appropriate policies to strengthen the coupling effect of the two industries.

4. Summary

Arterial industry and venous industry occupy an important position in China's economic development, which are the important impetus of economic growth and social progress in our country.

The coupling development of arterial industry and venous industry is the inevitable choice for China to get out of the crisis of resources and environment. For this reason, combined with the relevant theoretical basis, this paper makes an empirical analysis of the coupling development of arterial industry and venous industry in Liaoning Province. Through the analysis, the following conclusions are obtained: The coupling degree between arterial industry and venous industry in Liaoning Province has been deepened. From the coupling course of more than 10 years, the coordination degree of arterial industry and venous industry will transition to the next stage of development on average every 3-4 years. At present, the coupling development of arterial industry and venous industry has basically achieved primary coupling coordination. It is expected that the coupling development between the two industries will achieve intermediate coupling coordination in the next few years.

References

[1] Bruvoll A. The costs of alternative policies[J]. Statistics Norway, 1998.

[2] Hawley J M. Textile recycling: A systems perspective[J]. Recycling in textiles, 2006.

[3] Dehua Wu, Songling Chen. An integrated development of arterial industry and venous mining space decision Support system design [J]. Surveying and mapping science, 2014,07:158-162.

[4] Pengliang Qiao. A study on the coupling development of strategic emerging industries and traditional industries in Guangxi Province [J]. Guangxi Social Sciences, 2014,03:24-27.

[5] Xiaodong Wang. Study on the interaction between arterial industry and venous industry [J]. Research on technology economics and Management, 2012,06:92-95.

[6] Shuang Zhang, Hongda Zhang. Breakthrough Low Carbon bottleneck: a comparison between arterial industry and venous industry synergy and development model [J]. Social science research, 2013,05:94-98.