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Research on the Coupling and Coordinated Development of Ecological Civilization Construction and Economic Growth level— A Case Study of Shaanxi Province, China

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Abstract: With the increasingly prominent contradiction between ecological environment and economic development in China, comprehensive, coordinated and sustainable development has gradually become the theme of economic and social development in various Chinese provinces and cities. This paper takes Shaanxi Province of China as an example to analyze the coupled coordinated development of ecological civilization construction and economic growth level effect in Shaanxi province from 2009 to 2019 by constructing a multi-index comprehensive evaluation system and using the coupled development model. The results show that the coupling degree and the coordination degree of coupling between the ecological civilization construction and the economic growth level in Shaanxi province are on the rise, and there is an obvious coupling relation between them. In 2009, the coupling coordination degree was slightly maladjusted, increased to moderate coordination in 2010-2011, and gradually increased to high coordination in 2012-2019. Shaanxi province should maintain a highly coordinated trend of ecological civilization construction and economic growth, and strive to develop towards an extremely coordinated trend.

Keywords: Ecological civilization construction; Economic growth effect; Multi-index evaluation system; Coupled development model

1. Introduction and Literature Review

As the disadvantages of the extensive traditional economic development model begin to be exposed, the contradiction between ecological protection and economic development becomes increasingly acute [1]. Countries and regions gradually realize the importance of sustainable development, green development, circular economy and other development models. In recent years, the rapid Chinesegrowth, modern

industrialization, urbanization, and economic development have seriously increased resource shortage, environmental pollution, and ecosystem degradation problems in several Chinese regions. Becoming the contradiction between the traditional economic development model, with high consumption and pollution, and ecological civilization's construction increasingly prominent. Simultaneously, China's economic transformation from high-speed development to high-quality development faces the imperative challenge to drive economic development through green development. Ecological progress bears on the sustainable development of a country and the well-being of its people.In this regard, the ecological civilization and economic development issue have always been in the academic research focus, and many scholars have conducted relevant research on this issue.

This relationship between ecological civilization and economic development had raised scholars' interest since the 1970s and have gradually become more important till the 1990s, when it became the focus of ecological economics and environmental economics. Crossman *et al.* [2] put forward the concept of EKC (Environment Kuznets Curve), indicating that the relationship between economic development and environmental pollution presents an inverted "U" shape.This provides the foundation for the study of economic development andecology. On this basis, scholars made empirical analyses on their research objects and verified the rationality of the EKC existence(e.g., THEODORE and PANAYOTOU [3]; ORUBU *et al.* [4]; He [5]). Actual structural and economic development model changes have made many scholars question the EKC (e.g., Brajer V et al. [6]; MARTINEZ-ZARZOSO I [7]; Deng *et al.* [8]). They generally believe that the relationship between economic growth and the environment in a certain period is positive, and it can be represented as"U" type, "N" type, "W" type and other forms. The EKC hypothesis's also progressed, with many scholars adding new models and methods, which enrich the theoretical basis of EKC hypothesis. For example, the threshold space measurement model [9], double threshold effect [10] and extensible stochastic environmental impact assessment model [11] are used.

There are also many different research methods on ecological civilization construction and economic development, which are mainly divided into qualitative and quantitative analysis. Some scholars expounded on the relationship between ecological civilization construction and economic development from a qualitative perspective. According to the coupling mechanism of industrial cluster and regional economic development, Wu Qiantang [12] analyzed the coupling mechanism from the aspects of

industrial cluster and regional advantages, regional economic structure adjustment, regional economic opening, regional market operation efficiency and so on.Other scholars use quantitative research methods for empirical analysis. Bunce [13] used multiple factor variables to construct the evaluation index system. His research showed that endogenous variables significantly influence the interaction between the ecological environment and economic development. Wu et al. [14] developed a decoupling index of the relationship between economic growth and carbon emissions, and built a decoupling model to analyze the spatial-temporal coupling relationship between economic growth and carbon emissions in Shanxi, Shaanxi and Inner Mongolia.

In the study of the relationship between ecology and economy, "eco-economic coupling" is one of the frontiers of ecological economics. Coupling is a physical concept representing a dynamic correlation between systems that interact with each other and achieve coordinated symbiosis [15]. Similarly, the whole system is divided into two subsystems: ecological civilization construction and economic growth effect.The phenomenon where the two subsystems interact and influence each other through their coupling elements is called the coupling relationship [16,17,18]. At present, most of the system coupling theories have been applied in the tourism-economic system [19], ecology-urbanization system [20,21], environment-economic system [22,23], etc., but there are few studies on the ecology-economic system. In addition, the evaluation index system constructed by some studies is incomplete and does not consider the heterogeneity of different regions, so it is difficult to cover all the information, and the evaluation method adopted is highly subjective.

Therefore, based on the development status of Shaanxi Province in China, this paper seeks a strategic plan to improve the coordinated development of energy, environment, society and economy. To this goal, itcombines qualitative and quantitative analysis to study the coupling degree and coordination degree of ecological civilization construction and economic development in different years in several. Furthermore, this paper discusses the temporal and spatial changes of the coordination degree between ecological civilization construction and economic development in Shaanxi. This paperexpects to improve the Shaanxi province's sustainable development and promote the coordinated development of ecological civilization construction and economic growth. Thus, providinga successful case for global sustainable development construction.

The remainder of the paper is organized as follows. Section 2 constructs the evaluation index system of coupled and coordinated development, the

coupling development model and the systematic development model of ecological civilization construction and economic growth. Section 3 is the empirical analysis and the result discussion.The last section summarizes the main conclusions.

2. Material and Methods

2.1. Region Selection and Data Sources

Shaanxi province lies in northwest China's hinterland, straddling the middle of the Yellow River and the Yangtze River. It is an important hub connecting China's eastern and central regions with the northwest and southwest, covering 205,800 square kilometers and jurisdiction over one sub-provincial city and nine prefecture-level cities. Shaanxi is an important region for development and opening up in northwest China [24]. By the end of 2019, Shaanxi had a total population of 38.64 million, with an urbanization rate of 58.13%, a regional GDP of 2.44 trillion yuan, and an economic aggregate in the middle level of the country. With the rapid social-economic development, resources and environmental problems are becoming more and more prominent.Moreover, with the national strategies deepening such as "One Belt And One Road", Shaanxi will further give play to its regional advantages and fully tap its development potential. However, how to successfully develop the economy while achieving a coordinated ecological civilization and economic development is the key problem to be solved urgently in Shaanxi's sustainable development research.Therefore, this paper selects Shaanxi for empirical analysis to study the coupling relationship between ecological civilization construction and economic development level in Shaanxi province from 2009 to 2019.This paper's relevant datais taken from the Statistical Yearbook of Shaanxi Province and the National Bureau of Statistics of China.

2.2. The Evaluation Index System Construction

In this paper, a reasonable and complete evaluation index system of ecological civilization construction and coordinated development of economic growth is constructed based on the comprehensive consideration of the current situation of China's economic and ecological development and the availability of various index data. The whole target layer is divided into two subsystems: the ecological civilization construction system and the economic growth level system. The specific evaluation index system is shown in Table 1:

Table 1: Evaluation index system of coupled and coordinated development of ecological civilization construction and economic growth

The target layer	*System layer*	*Primary index layer*	*Secondary index layer*	*unit*	*trend*
Ecological and economic coupling coordinated development system	Ecological civilization construction system	Economic utilization of resources	Provincial electricity consumption &	Million kw·h	Negative
			Energy consumption per unit of GDP	Tons of standard coal/1000 yuan	Negative
		National space Optimization	Urban green area &	hm^2	Positive
			Urban built-up area	km^2	Negative
		Ecological environment's protection	Forest cover rate &	%	Positive
			Environmental pollution control investment as a share of GDP	%	Positive
	Economic growth level system	Economic growth rate	Per capita GDP growth rate & Local fiscal revenue	%	Positive
			Growth rate	%	Positive
		People's livelihood development range	Per capita disposable income & Family	Yuan	Positive
			Engel coefficient	%	Negative

In Table1, the ecological civilization construction system contains three first-level indicators: economic utilization of resources, national space optimization, and the ecological environment's protection. The economic utilization of resources includes the provincial electricity consumption and energy consumption per unit of GDP, two reverse indicators. Energy consumption per unit of GDP is an energy efficiency indicator, reflecting the total energy consumption ratio to GDP. The higher the energy consumption per unit of GDP, the lower the efficiency of resource conservation and utilization. The land resources optimization includes a positive index of urban green area and a negative index of urban built-up area. The urban green space area reflects the greening level in the urbanization economic development, and the urban built-up area reflects the size of the urbanization area. The ecological environment's protection includes two positive indicators: forest coverage rate and the proportion of investment in environmental pollution control in GDP. The forest coverage rate is the forest area ratio to the total area, which measures the actual level of forest resources and forest land occupation. The proportion of investment in environmental pollution control in GDP reflects the importance the government attaches to ecological and environmental protection.

The economic growth level system contains two first-level indicators: the economic growth rate and the people's livelihood development range. The economic growth range includes two positive indicators: per capita GDP growth rate and the local fiscal revenue growth rate. The people's livelihood development range consists of the per capita disposable income positive indicator and thefamily Engel coefficient negative indicator. Per capita disposable income determines individuals' and households' consumption expenditure, which largely reflects the country's living standard changes. The family Engel coefficient refers to the proportion of the total food expenditure regarding the total household expenditure. Generally speaking, an Engel coefficient of more than 59% means families are poor, 50-59% meansfamilies have adequate food and clothing, 40-50% families are well-off, 30-40% families are rich, and less than 30% are the wealthiest families [25].

Standardized treatment is carried out for different indicators. Specific treatment methods are as follows:

$$h_{ij} = \frac{x_{ij} - \min(x_{ij})}{\max(x_{ij}) - \min(x_{ij})} \tag{1}$$

$$h_{ij} = \frac{\max(x_{ij}) - x_{ij}}{\max(x_{ij}) - \min(x_{ij})} \tag{2}$$

In equation (1), x_{ij} is a positive indicator. In equation (2), x_{ij} is a negative indicator.

2.3. The Coupling Development Model of Ecological Civilization Construction and Economic Growth

The change process of ecological civilization construction and economic development level is nonlinear [26]. Therefore, this paper constructs a nonlinear function to analyze the dynamic change and evolution process of coupled development between ecological civilization construction and economic development level:

$$\frac{dx(t)}{dt} = f(x_1, x_2, \cdots x_i \cdots x_n), \quad i = 1,2,3,\cdots n \tag{3}$$

Where, x represents the system, x_i represents the ith index inside the system, and t represents time, which is the x_i's nonlinear function. Since the property of the characteristic root of each approximate system determines the stability of the nonlinear change process, the function is expanded near the characteristic root of the system according to Taylor series, and the expansion term of the highest power is ignored. The approximate linear expression of the above nonlinear function can be obtained as follows:

$$\frac{dx(t)}{dt} = \sum_{i=1}^{n} \omega_i x_i, i = 1,2,\cdots n \tag{4}$$

In the above equation, ω_i represents the weight of the i th influence index in the system.

According to Equation (4), the nonlinear development function of the dynamic development and change process of ecological civilization construction and economic growth level is as follows:

$$f(E) = \sum_{i=1}^{n} a_i x_i, i = 1,2,\cdots n \tag{5}$$

$$f(F) = \sum_{j=1}^{n} b_j x_j, j = 1,2,\cdots n \tag{6}$$

f(E) is the change function of ecological civilization construction and development, and *f(F)* is the change function of economic growth level. x and y represent the influencing factors in the change system of ecological civilization construction and economic growth level, respectively, which

are functions of time variable (t). a and b represent the weights of various influencing factors.

According to the nonlinear development function in formula (5) and (6), the coupling degree between ecological civilization construction and economic growth level is further calculated. Thus, the coupling degree model of ecological civilization construction and economic growth level is given in the following formula:

$$C = 2 \times \frac{\sqrt{f(E) \cdot f(F)}}{f(E) + f(F)} \tag{7}$$

C represents the coupling degree between ecological civilization construction and economic growth level. Since the nature of the inequality is $2\sqrt{xy} \le x + y$, it can be deduced that the coupling degree value interval of C is: [0,1].

Coupling degree C reflects the coordination degree of development between systems, which cannot effectively reflect the coordinated development level between systems [27]. Therefore, coordination degree D is further introduced in this paper to represent the coordination degree between systems. Based on the coupling model and coupling degree model, the coupling degree model of ecological civilization construction and economic development level is deduced as follows:

$$T = gf(E) + hf(F) \tag{8}$$

$$D[f(E), f(F)] = \sqrt{CT} = \sqrt{2 \times \frac{\sqrt{f(E) \cdot f(F)}}{f(E) + f(F)} \cdot [gf(E) + hf(F)]} \tag{9}$$

T is the comprehensive development index of ecological civilization construction and economic growth level, representing the overall development level of the comprehensive development process of ecological civilization construction and economic growth level. g and h represent the weights of ecological civilization construction system and economic growth level system, which are both undetermined coefficients. As the ecological civilization construction and the economic development are of equal importance to regional development, g and h are both 0.5. $D[f(E), f(F)]$ is the coupling degree and coordination between ecological civilization construction and economic growth level, reflecting the coordination and consistency of coupling changes between them. According to the inequality properties, the value range of $D[f(E), f(F)]$ is [0,1].

C and *D* values in different ranges represent different meanings, as shown in Table 2. When $C = 0$, the coupling degree between the ecological civilization construction system and the economic growth level system reaches the minimum value, indicating that the influencing factors between the two systems and the internal factors are irrelevant. When $0 < C \leq 0.1$, $0 < D \leq 0.1$, the ecological civilization construction and the level of economic growth are highly incompatible with each other as well as internal influencing factors, indicating that the correlation between the two development systems is extremely low. When $0.1 < C \leq 0.2$, $0.1 < D \leq 0.2$, there is a serious disharmony between ecological civilization construction and economic growth level as well as between internal influencing factors, indicating that the correlation between the two development systems is very low. When $0.2 < C \leq 0.3$, $0.2 < D \leq 0.3$, there is moderate disharmony between ecological civilization construction and economic growth level and between internal influencing factors, indicating that the two development systems' correlation degree is low. When $0.3 < C \leq 0.4$, $0.3 < D \leq 0.4$, there is a slight incongruity between ecological civilization construction and economic growth level and between internal influencing factors, indicating that the degree of correlation between the two development systems is at a low level. When $0.4 < C \leq 0.5$, $0.4 < D \leq 0.5$, the ecological civilization construction and the level of economic growth and the internal influencing factors are on the verge of disharmony, indicating that the degree of correlation between the two development systems is at a low level. When $0.5 < C \leq 0.6$, $0.5 < D \leq 0.6$, the ecological civilization construction and the level of economic growth and the internal influencing factors are barely coordinated, indicating that the degree of correlation between the two development systems is general. When $0.6 < C \leq 0.7$, $0.6 < D \leq 0.7$, there is low coordination between ecological civilization construction and economic growth level and the internal influencing factors, indicating that the degree of correlation between the two development systems is higher than the general level. When $0.7 < C \leq 0.8$, $0.7 < D \leq 0.8$, there is general coordination between ecological civilization construction and economic growth level as well as between internal influencing factors, indicating that the degree of correlation between the two development systems is relatively high. When $0.8 < C \leq 0.9$, $0.8 < D \leq 0.9$, there is a high level of coordination between ecological civilization construction and economic growth level as well as among internal influencing factors, indicating that the degree of correlation between the two development systems is at a high level. When $0.9 < C < 1$, $0.9 < D < 1$, there is a high level of coordination between ecological civilization construction and economic growth level as well as between internal influencing factors,

indicating that the degree of correlation between the two development systems is at an extremely high level.

Table 2: Distribution Table of Coupling Degree *C* and Coordination Degree *D*

Coupling phase	*Coupling value C*	*Coordination degree of value D*	*Coordination type*
Low level	0<C≤0.1	0<D≤0.1	
	0.1<C≤0.2	0.1<D≤0.2	Low-grade coordination
	0.2<C≤0.3	0.2<D≤0.3	
Equivalent level	0.3<C≤0.4	0.3<D≤0.4	Low-grade coordination
	0.4<C≤0.5	0.4<D≤0.5	Moderate coordination
Above average	0.5<C≤0.6	0.5<D≤0.6	
level	0.6<C≤0.7	0.6<D≤0.7	High coordination
	0.7<C≤0.8	0.7<D≤0.8	
High level	0.8<C≤0.9	0.8<D≤0.9	
	0.9<C<1	0.9<D<1	Extreme coordination

2.4. A Systematic Development Model of Ecological Civilization Construction and Economic Growth

Because ecological civilization construction and economic growth level development are mutually influencing and gradually evolving, ecological civilization construction and economic growth level can be analyzed as a whole complex system. $f(E)$ and $f(F)$ are the leading parts of this complex system. In order to further verify the relationship between ecological civilization construction and economic growth level in a time dimension, functions $f(E, t)$ and $f(F, t)$ are constructed and differentiated [28].

$$E = f(E,t) = \frac{df(E)}{dt} = \alpha_1 f(E) + \alpha_2 f(F) \tag{10}$$

$$F = f(F,t) = \frac{df(F)}{dt} = \beta_1 f(E) + \beta_2 f(F) \tag{11}$$

$$V_E = \frac{df(E,t)}{dt}; V_F = \frac{df(F,t)}{dt} \tag{12}$$

State E and State F are the guiding factors which lead the whole ecological and economic coupling coordinated development system. The trend and direction of the whole system's dynamic evolution and the final state are determined by the two dominant parts, state E and State F. In the process of system evolution, the two dominant factors are affected by each other's changes. V_E and V_F represent the evolution speed of the two subsystem layers, and they are markers to measure the overall speed of the

whole development system. In order to analyze the whole system evolution speed, the dynamic coupling relationship between ecological civilization construction and economic growth level development is regarded as periodic change, and two-dimensional graphical mathematical modeling is carried out to represent the evolution speed state of E and F.

Assuming that the coupling relationship between ecological civilization construction and economic growth changes periodically, the inverse tangent function ($\alpha = \arctan(V_E / V_F)$) with V_E and V_F ratio is used to measure the coordination relationship between the two subsystems. There are four stages in the coupling development and evolution of ecological civilization construction and economic growth. When $-90° < \alpha \leq 0°$, the coupled development and change system of ecological civilization construction and economic growth are at a low-level coordination stage. When $0° < \alpha \leq 90°$, the coupled development and change system of ecological civilization construction and economic growth are in the stage of coordinated development. At this time, the development of ecological civilization construction and economic growth level is in the middle and high-speed stage, and the promotion effect of ecological civilization construction and economic growth level is emerging. However, the effect's intensity is not obvious, which cannot make the entire changing system have a qualitative change. When $90° < \alpha \leq 180°$, the entire change system is in the state of extreme development, and ecological civilization construction and economic growth level are in the state of rapid development and change. When $-180° < \alpha \leq -90°$, the entire change system is in a spiraling upward evolution state, the development and relationship between ecological civilization construction and economic growth level gradually evolve from a threatening relationship to a mutual promotion relationship, and the entire change system is in a high-level and coordinated development state [28].

3. Results and Discussion

3.1. Dynamic Research on the Development Trend of Ecological Civilization Construction and Economic Growth Level

The multi-index evaluation system's weight setting will have an important influence on the research results' accuracy. Among all weighting methods, the entropy weighting determineseach index's weight according to the index's dispersion degree, with high precision and a wide application range. It can avoid the subjective factor influence in the empowerment process to the greatest extent [29]. Therefore, according to the basic principle of entropy weight method, this paper calculates each index's influence weight in the

second-level index layer. The corresponding weight calculation results obtained by the entropy weight method are shown in Table 3:

Table 3: Calculation results of the weight of ecological civilization construction and economic growth system evaluation index

System layer	*Secondary index layer*	*weight*
Ecological civilization construction system	Provincial electricity consumption & Energy consumption per unit of GDP & Urban green area & Urban built-up area & Forest cover rate & Environmental pollution control investment as a share of GDP	0.1572 & 0.1434 & 0.1215 & 0.1602 & 0.2296 & 0.1881
Economic growth level system	Per capita GDP growth rate & Local fiscal revenue growth rate & Per capita disposable income & Family Engel coefficient	0.2732 & 0.1839 & 0.3168 & 0.2261

According to formula (5) and (6), the development trend of ecological civilization construction and economic growth level in Shaanxi is shown in Figure 1:

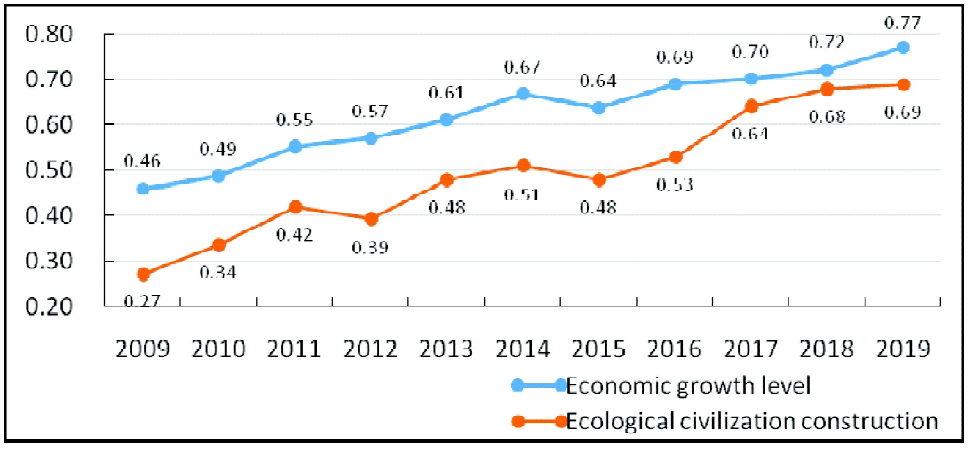

Figure 1: Development trend of ecological civilization construction and economic growth level in Shaanxi province from 2009 to 2019

Figure 1 shows that from 2009 to 2019, both Shaanxi's ecological civilization construction and economic growth level presented an upward trend. The economic growth level rose steadily and the ecological civilization construction moved slightly. Overall, both the economic growth level and the speed of ecological civilization construction have been relatively fast in the past decade. The two are influencing each other in a steady rise, and there is a coupling development relationship.

3.2. *Analysis of Coupling Degree Between Ecological Civilization Construction and Economic Growth Level*

According to formulas (7) - (9), coupling degree *C* and coupling coordination degree *D* are shown in Figure 2:

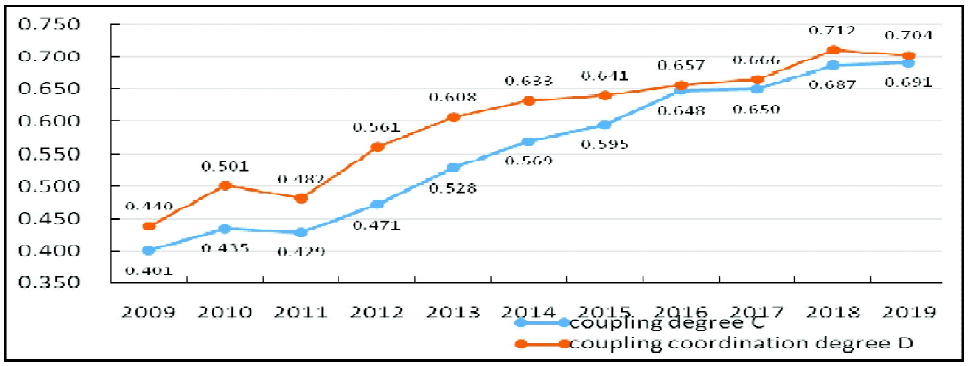

Figure 2: Coupling and coordination analysis of ecological civilization construction and economic growth level in Shaanxi Province from 2009 to 2019

Figure 2 shows that the coupling degree *C* and the coupling coordination degree *D* of the ecological civilization construction and economic growth level in Shaanxi from 2009 to 2019 have an overall rising trend. Coupling degree *C* shows that the ecological civilization construction and the economic growth level in Shaanxi province from 2009 to 2012 are equivalents. At this point, the coupling value is within the range of (0.4, 0.5), indicating that the two change systems' development present a noticeable difference.The economic growth level has been significantly improved, and the ecological civilization construction is affected byeconomic growth, which cannot be eliminated. From 2013 to 2019, the coupling development of ecological civilization construction and economic growth level in Shaanxi has entered the above-average level. At that time, the coupling degree *C* is within the range of (0.5, 0.7). Meaning that the ecological civilization construction and the economic growth level are constantly developing, and there is an obvious coupling relationship

between them, and both sides promote each other. Specifically, ecological civilization construction provides the foundation for economic growth, and economic growth provides more financial support for the investment and ecological civilization construction.

The coupling degree coordination value *D* shows that Shaanxi's coupling degree of ecological civilization construction and economic growth level fluctuates greatly from 2009 to 2012. However, after 2012, the coupling degree shows a steady rise trend. In 2009, the ecological civilization construction and economic growth level of Shaanxi were slightly unbalanced. In 2010-2011, ecological civilization construction and economic growth were at an equivalent level. At this point, the coordination value D of coupling degree is distributed within the range of (0.4, 0.5), and the development of ecological civilization construction and economic growth level presents a moderately coordinated trend. From 2012 to 2019, ecological civilization construction and economic growth level are at the above-average level. At this time, the coordination value D of coupling degree is distributed within the range of (0.5, 0.8), and the two are in a highly coordinated development trend.

3.3. *Analysis of the Coupling Coordination Degree Between Ecological Civilization Construction and Economic Growth Level*

In this paper, Eviews 8.0 software is used to analyze the two dynamic development and change curves of ecological civilization construction and economic growth level. Carrying out a regression function of ecological civilization construction and economic growth level provides the following results:

$$f(E,t) = 0.0074t^2 - 4.813t + 23.41 \quad (R^2 = 0.9335) \tag{13}$$

$$f(F,t) = 0.0026t^2 - 6.368t + 31.25 \quad (R^2 = 0.9017) \tag{14}$$

By differentiating two functions of equations13 and 14, we can get:

$$V_E = \frac{df(E,t)}{dt} = 0.0148t - 4.813 \tag{15}$$

$$V_F = \frac{df(E,t)}{dt} = 0.0052t - 6.368 \tag{16}$$

According to the functional expressions of and above, the included angle formed by the development system change rate of ecological civilization construction and economic growth level from 2009 to 2019 can be obtained, as shown in figure 3 below:

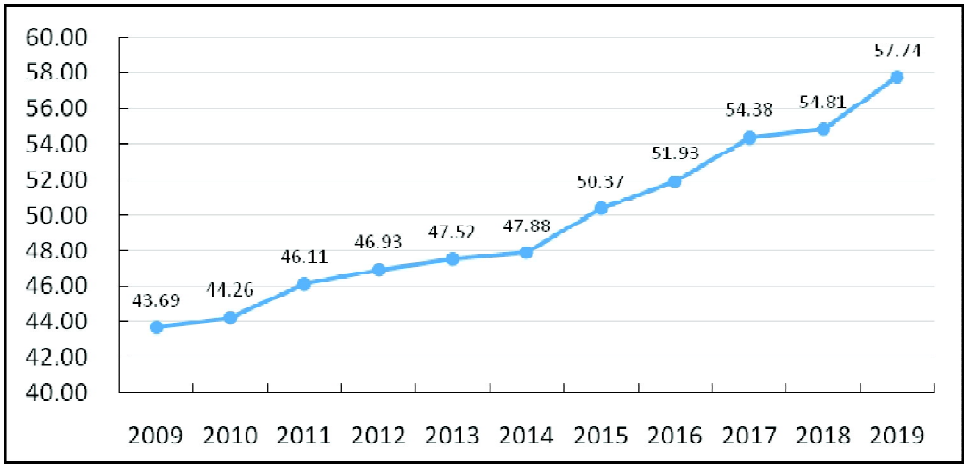

Figure 3: A systematic analysis of ecological civilization construction and economic growth level development in Shaanxi Province from 2009 to 2019

Figure 3 shows that the included angle formed by the developmentrate of ecological civilization construction and economic growth level in Shaanxi province from 2009 to 2019 is within the range of [40°,60°]. During this period, the coupling development system of ecological civilization construction and economic growth level in Shaanxi is in the coordinated development stage. The development of ecological civilization construction and economic growth level is separatelyin a moderate and high-speed stage, and there is mutual influence and mutual coordination promoting effect. The angle degree of the two increased year by year, indicating that their action intensity gradually increased. Furthermore, between 2009 and 2010 the angle was between [0°, 45°], suggesting that economic growth began to impact ecological environment construction, becoming the supporting role of ecological environment on economic development gradually noticeable. Since 2011, the angle degree has been between [45°and 90°], indicating that the coordinated development of ecological environment construction and economic growth level continues. Ultimately, the two will be extremely coordinated, reaching a stage of consistent development and common development.

4. Conclusions

Taking Shaanxi Province of China as an example, this paper constructs a comprehensive evaluation index system of ecological civilization construction and economic growth level. By analyzing the coupling and coordination of ecological civilization construction and economic growth level in Shaanxi from 2009 to 2019, the following conclusions are drawn:

(1) From 2009 to 2019, both the ecological civilization construction and economic growth level of Shaanxi showed an obvious upward trend, indicating that Shaanxi's ecological civilization construction and economic growth level were relatively fast in recent years. Also, suggesting that Shaanxi's ecological civilization construction may have a certain promotion effect on economic growth, with a coupling development relationship between the two.

(2) From 2009 to 2019, the coupling degree value *C* and the coupling coordination degree value *D* of the ecological civilization construction and economic growth level in Shaanxi showed an overall rising trend. The coupling coordination state increased from near disharmony in 2009, i.e., mild disharmony, to moderate coordination in 2010-2011. Since 2012, Shaanxi's ecological civilization construction and economic growth level have been gradually blending into each other and rising to a highly coordinated development trend.There is a noticeable coupling relationship between the two, and both sides promote each other.

(3) From 2009 to 2019, the included angle formed by the development speed of ecological civilization construction and economic growth level has always been within the range of [40°,60°]. Simultaneously, the coupling degree of ecological civilization construction and economic growth level is at a relatively high coordination level, indicating that the two can promote, coordinate and develop each other.

To sum up, the coupling level and coordination between ecological civilization construction and economic growth level in Shaanxi province are on the rise, and there is a large room for rise. Economic development is the driving force to promote the coordinated and coupled development of ecological civilization construction and economic growth level. In contrast, ecological civilization construction is the premise and guarantee of economic development. While speeding up economic development and pursuing economic growth level effect, Shaanxi Provincial government should pay more attention to the construction of ecological environment and ecological civilization, and integrate ecological civilization's construction into law development, system, economy and culture. The government should also take the lead in introducing market resources into ecological civilization construction,increasing investment and financing for ecological civilization construction. In this way, we can coordinate economic development and ecological environment construction, form favorable support for economic development, and build Shaanxi province into a part of a beautiful China in an all-round, wide-ranging and multi-level way.

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