

Relationship on Knowledge Innovation and High-quality Economic Development

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Abstract:

In theory, high-quality economic development is significantly promoted by knowledge innovation, and the key factors of high-quality economic is positively affected by knowledge innovation. Empirically, the indexes weight is comprehensively evaluated through the triangular fuzzy entropy weighting method, and the linear regression analysis is used to research the relationship about knowledge innovation and high-quality economic development with the help of SPSS 19.0 software. The results show that knowledge innovation can significantly promote high-quality economic development, and play an positive role on the key factors of high-quality economic development, such as green ecology, openness and stability, Sharing and harmony and coordinated development. At the same time, there are significant differences in the contribution of key factors to high-quality economic development.

Keywords: *Knowledge innovation, High-quality economic development, Triangular fuzzy entropy, Input and output.*

I. INTRODUCTION

In 2020, under the influence of the COVID-19, China is the only country in the world that has achieved positive economic growth, and its GDP has exceeded the 10 billion mark, which fully demonstrates the resilience and vitality of China's economy. However, we also find that the side effects of the traditional extensive economic growth mode are becoming more and more obvious (such as environmental problems), which has gradually become an inhibitory factor for the further development of China's economy. How China's economy should develop in the future is a key issue that we need to continue to pay attention to. In the 19th National Congress of the Communist Party of China, the concept of high-quality development based on economic vitality, innovation and competitiveness was first proposed, and the outline of the 14th five year plan for national economic and social development of the People's Republic of China and long-term objectives for 2035 (hereinafter referred to as the "Outline") adopted at the fourth session of the 13th National People's Congress in March 2021, took high-quality development led by the new development concept as the theme of the country's future development. The adoption of this program has solved the major structural problems in China's economic and social development, and played a key role in cultivating new drivers of economic development and promoting the healthy and sustainable development of China's economy ^[1-2]. At the same time, the Outline emphasizes that innovation is the fundamental

driving force of high-quality development. During the 14th Five Year Plan period, the country should take the significant improvement of innovation ability as the development goal to promote high-quality economic development. The endogenous growth theory of Romer, the winner of the 2018 Nobel Prize in economics, takes knowledge innovation as the fourth element of economic growth and emphasizes the importance of knowledge innovation to economic development. CHEN Changbing (2018) research shows that in the process of innovation driving China's high-quality economic development in the new era, innovation is the fundamental driving force to economic development, and knowledge plays an important role^[3]. Therefore, knowledge innovation is bound to promote the high-quality development of China's economy.

II. LITERATURE REVIEW

High quality economic development is one of the hot issues in recent years, and relevant research has also produced fruitful research results. Through the collection and sorting of literature, it is found that the current research results on high-quality economic development mainly focus on two aspects: the research of high-quality economic development itself and the research of antecedents.

2.1 Research on High-Quality Economic Development Itself

The research on high-quality economic development itself mainly involves the connotation and measurement of high-quality economic development, that is, what is high-quality economic development and how to measure the development level. (1) On the connotation of high-quality economic development: the research group of the Economic Research Institute of the national development and Reform Commission (2019) emphasized that the core connotation of high-quality economic development had the characteristics of high quality, high efficiency and high stability of the supply system, and high-quality economic development could only be achieved when these characteristics were indispensable and do not conflict with each other^[4]. ZHANG Chao & TANG Jie (2021) linked high-quality economic development with sustainable development and high-quality economic growth, and expounded the connotation of high-quality economic development from the comprehensive, phased and regional characteristics of economic development quality^[5]. ZHANG Zhen (2021) paid attention to the regional characteristics of economic development and pointed out that high-quality development of regional economy could significantly improve economic growth and sustainability, and promote the benign interaction between economy, society and ecology. Its connotation covered the driving force of regional innovative development, innovative development conditions and the degree of openness^[6]. Some other scholars have expounded the connotation of high-quality economic development from the perspective of Marxist political economy, theoretical significance and the transformation of old and new kinetic energy^[3, 7-8]. (2) About the measurement of high-quality economic development, based on the summary of WANG Wenju and YAO Yijia (2021), this paper divides the research on the measurement of high-quality economic development level into three categories^[9]: Firstly, a single index measures the high-quality economic development level: such as SANG Qianqian, LI Yuxiang^[10] (2021), LIU Bo et al.^[11] (2021), etc., which uses total factor productivity to represent the high-quality economic development level. LI Kai,

SHANGGUAN Xuming (2021) represented the high-quality development level of regional economy with green total factor productivity^[12], etc. Secondly, measure the high-quality economic development level based on the new development concept: many scholars, based on the new development concept, expressed the high-quality economic development level from the perspectives of innovation, green, openness, sharing and coordination, such as YU Chaoyi and WANG Xuebiao^[13] (2021), LIU Tao and HAN Yue^[14] (2021), HU Deshun et al.^[15] (2021), the research group of Henan University of Finance and economics and law^[16] (2021), etc. Thirdly, measure the level of high-quality economic development based on the connotation and characteristics of high-quality economic development: for example, YANG Yanfang et al. (2021) measured high-quality economic development from the perspectives of effectiveness, coordination and sustainability^[17]. SONG Meizhe (2021) based on the theoretical connotation of high-quality economic development, and the economic input-output efficiency calculated by DEA method reflected the high-quality economic development level^[18], etc.

2.2 Study on the Antecedents of High-Quality Economic Development

The research on the antecedents of high-quality economic development mainly discusses the analysis of the influencing factors of high-quality economic development. According to the current research results, scholars' research on the antecedents of high-quality economic development can be divided into two categories: single factor and multiple factors. (1) Single factor: R & D input played a strong role in promoting endogenous economic growth. High-quality economic development was about the common growth of economic quantity and quality. The importance of R&D input to high-quality economic development was self-evident, and there was a significant positive impact^[16, 19]. SUN Yixuan et al. (2021) used the data of 30 provinces (autonomous regions and municipalities) in China to explore the problems of scientific and technological innovation and high-quality economic development. The research showed that various elements of scientific and technological innovation had a strong driving effect on high-quality economic development^[20]. This view was supported by CHEN Zhangxi, ZHUANSUN Guanhua^[21] (2021), Wei Qifeng et al.^[22] (2021). The research of YU Chaoyi and WANG Xuebiao (2021) showed that financial innovation had a threshold effect on promoting high-quality economic development. The higher the matching degree between financial services and the real economy, the more obvious the effect of financial innovation on improving the quality of economic growth^[13]. (2) Multiple factors: FENG Mengli and HU Wen (2021) studied the role of innovation system on high-quality economic development from the perspectives of scientific and technological innovation and institutional innovation, and pointed out that high-quality economic development is affected by both^[23]. LIU Bo et al. (2021) started from the three dimensions of banking structure, financing structure and R&D input. Through the macro data research of 31 provinces (autonomous regions and cities) from 2008 to 2017, they found that banking structure and financing structure had a significant impact on high-quality economic development, and R & D input played a significant intermediary role between banking structure and high-quality economic development^[11]. JIA Hongwen et al. (2021) analyzed the action mechanism of scientific and technological innovation and industrial structure upgrading on high-quality economic development, and pointed out that scientific and technological innovation significantly promotes high-quality economic development, while industrial structure upgrading has a significant inhibitory effect. However, under the action of scientific and

technological innovation, the negative impact of industrial structure upgrading on high-quality economic development disappears, thus indirectly promoting high-quality economic development^[24]. LIU Tao and HAN Yue (2021) believed that there was a causal relationship between innovation efficiency, double effect opening-up and high-quality economic development. Through empirical research, they concluded that innovation efficiency and two-way opening-up played a significant role in promoting high-quality economic development, and their synergistic effect also positively affected high-quality economic development^[14].

To sum up, the relevant research on high-quality economic development has achieved fruitful research results. In terms of the measurement of high-quality economic development level, the measurement based on the new development concept has been favored by many scholars. In the antecedent research, although many scholars explore the influencing factors of high-quality economic development from different dimensions, the essence of high-quality economic development is innovation driven. Therefore, among many factors, innovation has always been focused by scholars, and knowledge is the source of innovation. Knowledge innovation is the basis of all innovation activities. Therefore, knowledge innovation should play a significant role in high-quality economic development. Relying on the new development concept, this paper explores the problems of knowledge innovation and high-quality economic development. Its main contributions are as follows: (1) theoretically, this paper first explains the role relationship of knowledge innovation on high-quality economic development, and then puts forward the influence relationship of knowledge innovation on all dimensions of high-quality economic development from the perspective of innovation input and output, and puts forward relevant theoretical research hypotheses. (2) Empirically, with the help of triangular fuzzy entropy combination weighting method^[25] and regression analysis, this paper studies and analyzes the relationship between knowledge innovation and high-quality economic development.

III. HYPOTHESES AND MODEL CONSTRUCTION

High quality economic development is the transformation of economy from extensive growth to intensive growth. Its development process involves many problems, such as industrial structure upgrading, new power cultivation, supply side transformation and upgrading, sustainability and so on. The solution of this series of problems needs innovation. The Fifth Plenary Session of the 19th CPC Central Committee also pointed out that innovation was the first driving force leading development and the source of high-quality economic development. In the final analysis, innovation is knowledge. Knowledge innovation must be the core internal driving force of high-quality economic development. Paying attention to knowledge innovation is not only the guarantee of innovative economic growth mode, but also can promote the unity of economic growth and development.

3.1 Hypotheses

(1) Hypotheses of knowledge innovation on high-quality economic development

Innovation driven is the core mode of high-quality economic development, and knowledge innovation is the process of producing new science and technology and the category of basic innovation. Firstly, knowledge innovation can not only improve labor productivity and shorten the depreciation and renewal time of fixed capital, but also expand the social division of labor and industrial structure, produce new production industries of means of production and consumption, and capitalism has a long-term and significant economic growth^[26]. At the same time, knowledge innovation also has a positive effect on regional economic development and the reconstruction of the driving force of economic development^[27-28]. Secondly, knowledge innovation is the basis of scientific and technological innovation. Knowledge innovation is bound to lead to scientific and technological innovation and changes, promote the improvement of production efficiency, and realize the endogenous sustainable development of economy through knowledge spillover. The positive effect of scientific and technological innovation on high-quality economic development has been confirmed by most scholars^[20-22, 24].

Therefore, the article believes that knowledge innovation can effectively promote high-quality economic development, and makes relevant assumptions as follows:

Hypothesis I: Knowledge innovation has a significant positive impact on high-quality economic development.

(2) Hypothesis of the role of knowledge innovation on the dimensions of high-quality economic development

According to the new development concept, high-quality economic development involves five factors: innovation, green, openness, sharing and coordination. Innovation is the core, while knowledge innovation includes many factors of innovation. Therefore, this paper divides high-quality economic development into four dimensions: green ecology, openness and stability, sharing and harmony, and coordinated development. Meanwhile, referring to the relevant research of FENG Mengli and HU Wen (2021), knowledge innovation is divided into two dimensions: innovation input and innovation output^[23].

Firstly, green ecology is the basic requirement of high-quality economic development, and it is the inevitable requirement for advocating the harmonious development between man and nature, and solving the problems of resource constraints and ecological environment degradation. Secondly, opening up and stability is a necessary way to build a domestic and international double cycle with the domestic big cycle as the main body. By improving the linkage ability of domestic and foreign markets and resources, we can give full play to the institutional and market advantages of China's economic development, enhance the competitiveness of China's economy and realize high-quality economic development. Thirdly, sharing and harmony pay attention to social fairness and justice, and advocate that the whole people share development

dividends and adhere to the development goal of common prosperity. These are the essential requirements of socialism with Chinese characteristics. Finally, coordinated development focuses on solving the long-term problem of unbalanced economic development. The ultimate goal is to narrow the gap and achieve balanced economic development in regions, urban and rural areas and industries.

Therefore, combined with hypothesis I, this paper further makes a series of research hypotheses on the dimensions of high-quality economic development from the dimensions of knowledge innovation, as follows:

Hypothesis II: both input and output of knowledge innovation have a significant positive impact on green ecology.

Hypothesis III: both input and output of knowledge innovation have a significant positive impact on openness and stability.

Hypothesis IV: both input and output of knowledge innovation have a significant positive impact on sharing and harmony.

Hypothesis V: both input and output of knowledge innovation have a significant positive impact on coordinated development.

3.2 Model Construction

Based on the above assumptions, this paper constructs a correlation regression analysis model according to the idea of linear regression analysis, as follows:

$$\text{Model I: } Y = a \times X + b;$$

$$\text{Model II: } Y_1 = a_1 \times X_1 + a_2 \times X_2 + b;$$

$$\text{Model III: } Y_2 = a_1 \times X_1 + a_2 \times X_2 + b;$$

$$\text{Model IV: } Y_3 = a_1 \times X_1 + a_2 \times X_2 + b;$$

$$\text{Model V: } Y_4 = a_1 \times X_1 + a_2 \times X_2 + b;$$

In model I, 'Y' represents high-quality economic development and X represents knowledge innovation. In models II, III, IV and V, 'Y1', 'Y2', 'Y3' and 'Y4' respectively mean green ecology, openness and stability, sharing and harmony and coordinated development, 'X1' and 'X2' represents the input and output of knowledge innovation respectively.

IV. INDEX SELECTION AND INDEX WEIGHT

4.1 Index Selection

Based on the research results of existing scholars [13-16, 21-22], taking knowledge innovation as the key index, combined with the new development concept and comprehensively considering the connotation and characteristics of high-quality economic development, this paper finally obtains the index system of knowledge innovation and high-quality economic development, as shown in TABLE I.

TABLE I. Index system

PRIMARY INDEX	SECONDARY INDEX	TERTIARY INDEX	MEASUREMENT METHOD	INDEX ATTRIBUTE
KNOWLEDGE INNOVATION \mathcal{X}	Innovation input \mathcal{X}_1	Capital input level \mathcal{X}_{11}	R&D/GDP	+
		Labor input level \mathcal{X}_{12}	Number of R & D personnel /GDP	+
	Innovation output \mathcal{X}_2	Patent authorization level \mathcal{X}_{21}	Number of patents authorized / Number of R & D personnel	+
		Transformation level of innovation achievements \mathcal{X}_{22}	Technology market turnover /GDP	+
HIGH-QUALITY ECONOMIC DEVELOPMENT \mathcal{Y}	Green ecology \mathcal{Y}_1	Exhaust emission \mathcal{Y}_{11}	Exhaust emission /GDP	-
		Wastewater discharge \mathcal{Y}_{12}	Wastewater discharge /GDP	-
		Solid waste output \mathcal{Y}_{13}	Solid waste discharge /GDP	-
		Air quality level \mathcal{Y}_{14}	Percentage of days with air quality reaching or better than grade II in the whole year	+
		Greening level \mathcal{Y}_{15}	Per capita green coverage	+
		Industrial energy consumption \mathcal{Y}_{16}	Industrial power consumption /GDP	-
	Openness and	Level of	Total foreign input	+

PRIMARY INDEX	SECONDARY INDEX	TERTIARY INDEX	MEASUREMENT METHOD	INDEX ATTRIBUTE
	stability y_2	foreign capital introduction y_{21}	/GDP	
		International trade level y_{22}	total imports and exports /GDP	+
		Attract international tourism level y_{23}	Tourism foreign exchange income /GDP	+
	Sharing and harmony y_3	Individual GDP level y_{31}	Per capita GDP	+
		Educational input y_{32}	Per capita fiscal expenditure on Education	+
		Number of beds in medical institutions y_{33}	Beds per 10000 people	+
		Number of doctors in medical institutions y_{34}	Doctors per 10000 people	+
		Social security and employment input y_{35}	Per capita financial social security and employment expenditure	+
		Medical and health input y_{36}	Per capita financial medical and health expenditure	+
	Coordinated development y_4	Income gap between urban and rural areas y_{41}	Rural per capita income / Urban per capita income	+
		Rationality of industrial structure y_{42}	Rationalization index of industrial structure	-

(1) Knowledge Innovation. Firstly, knowledge innovation input is mainly divided into capital input and labor input, in which the level of capital input is mainly measured by the percentage of R&D input in GDP. As for R&D input, the article refers to the research results of Wei Qifeng et al.^[22] (2021), and so research funds are represented by internal expenditure of R&D funds in this paper. As for labor input, the labor input level of knowledge innovation is mainly expressed as the percentage of the total number of Regional R&D personnel in regional GDP. Secondly, the output of knowledge innovation is expressed by the level

of patent authorization and the level of transformation of innovation achievements. The number of patent authorization generated by the R&D personnel of the unit using the level of patent authorization, that is, the percentage about the number of patent authorization in the total number of R&D personnel. The level of transformation of innovation achievements is measured by the technology market transaction volume contained in the unit GDP, that is, the percentage of the technology market transaction volume in GDP.

(2) High quality economic development. Referring to the research of scholars, this paper measures the high-quality economic development through four indicators: green ecology, openness and stability, sharing harmony and coordinated development. Combined with the existing research and the above analysis, it further obtains the measurement indicators and relevant measurement methods of secondary indicators such as green ecology, openness and stability, shared harmony and coordinated development. As shown in Table I, for the measurement of the rationality of industrial structure in coordinated development, this paper uses the calculation method of Wang Xuhui (2021) on the rationalization index of industrial structure [29], and the specific calculation formula is as follows:

$$E = \sum_{i=1}^n \left| \frac{y_i/L_i}{y/L} - 1 \right| = \sum_{i=1}^n \left| \frac{y_i/y}{L_i/L} - 1 \right| \quad (1)$$

In the formula 1, 'E' is the deviation degree of industrial structure, 'Y' is the output value, 'L' is the number of employees, and 'i' is the industry. The greater the value of 'E', the more unreasonable the industrial structure, that is, the index attribute is negative.

4.2 Index Weight

In the index system constructed in this paper, each index (primary index and secondary index) contains two or more sub-indexes. How to use the sub-indexes to make a more reasonable evaluation of the indexes, that is, the determination of the weight of each index, is an important problem to be solved in this paper. In this paper, the triangular fuzzy entropy combination weighting method is used to weight each index [25,30]. Triangular fuzzy entropy can comprehensively consider the factors of each sub index, and use entropy method and triangular fuzzy method to determine the weight of each sub index, so as to make the evaluation of each sub index more objective and reasonable.

(1) Entropy weight determination

The difference degree of each sub index relative to the index is expressed by entropy weight, and the weight is positively correlated with the difference degree. Compared with high-quality economic development 'Y', the calculation of entropy weight of the four sub-indexes: green ecology 'Y1', openness and stability 'Y2', sharing and harmony 'Y3', coordinated development 'Y4', were taken as an example in this paper, and the specific calculation process is as follows:

Firstly, build a judgment matrix. According to the evaluation criteria of judgment matrix elements (as shown in TABLE II.), the relevant judgment matrix of each sub index of high-quality economic development $\mathcal{D} = (d_{ij})_{n \times n}$ (n=4) is constructed.

TABLE II. Judgment matrix element score evaluation criteria

VALUE	CRITERIA
1	For Y, Y_i is as important as Y_j
3	For Y, Y_i is slightly more important than Y_j
5	For Y, Y_i is more important than Y_j
7	For Y, Y_i is much more important than Y_j
9	For Y, Y_i is significantly more important than Y_j
2,4,6,8	Between the importance of the above adjacent values
The reciprocal of the above numbers	Contrary to the above, Y_i and Y_j are of opposite importance

According to TABLE II, the judgment matrix D can be obtained as follows:

$$\mathcal{D} = \begin{pmatrix} 1 & 1/3 & 4 & 1/3 \\ 3 & 1 & 1/4 & 3 \\ 1/4 & 4 & 1 & 1/3 \\ 3 & 1/3 & 3 & 1 \end{pmatrix}$$

Secondly, calculate characteristic specific gravity matrix $\mathcal{G} = (g_{ij})_{4 \times 4}$.

$$g_{ij} = \frac{d_{ij}}{\sum_{j=1}^n d_{ij}} \quad (2)$$

In the formula 2, d_{ij} is the element of judgment matrix \mathcal{D} , and $i=1, 2, 3, 4, n=4$. The matrix \mathcal{G} can be obtained from formula 2.

$$\mathcal{G} = \begin{pmatrix} 0.1765 & 0.0588 & 0.7059 & 0.0588 \\ 0.4138 & 0.1379 & 0.0345 & 0.4138 \\ 0.0448 & 0.7164 & 0.1791 & 0.0597 \\ 0.4091 & 0.0455 & 0.4091 & 0.1364 \end{pmatrix}$$

Thirdly, Calculate the entropy matrix of each index $\mathcal{E} = (e_i)_{4 \times 1}$.

$$e_i = -\frac{1}{\ln n} \sum_{j=1}^n g_{ij} \times \ln(g_{ij}) \quad (3)$$

In the formula 3, g_{ij} is the element of judgment matrix \mathcal{G} , and $i=1, 2, 3, 4, n=4$. Therefore, the entropy matrix \mathcal{E} can be obtained.

$$\mathcal{E} = (0.6386 \quad 0.8076 \quad 0.6162 \quad 0.8249)^T$$

Fourthly, Calculate entropy weight set $\alpha = (\alpha_i)_{4 \times 1}$.

$$\alpha_i = \frac{1 - e_i}{n - \sum_{i=1}^n e_i} \quad (4)$$

In the formula 4, e_i is the element of judgment matrix \mathcal{E} , and $i=1,2,3,4$, $n=4$. So, we can get the entropy weight set α as shown below:

$$\alpha = (0.3248 \quad 0.1729 \quad 0.3449 \quad 0.157402)^T$$

(2) Triangular fuzzy weight determination

Firstly, expert scoring, for index I, expert J scores freely between 0 and 100, according to the three criteria of the most conservative, the most likely and the most optimistic, and obtains the triangular fuzzy number of index I. That is $\mathcal{T}_j = [a_{ij}, b_{ij}, c_{ij}]$, and in the \mathcal{T}_j , the value of I does not exceed the total number of indicators, and J's value does not exceed the total number of experts. Three experts are invited to score the indicators, and the scoring matrix of each indicator \mathcal{T} is as follows. The weights of the three experts are 0.3, 0.4 and 0.4 respectively, that is, the expert weight set \mathcal{F} is $(0.3, 0.4, 0.4)^T$.

$$\mathcal{T} = \begin{pmatrix} [23,41,62] & [21,42,59] & [26,46,60] \\ [21,39,55] & [22,39,55] & [22,39,51] \\ [22,40,61] & [23,41,53] & [25,43,61] \\ [19,38,51] & [20,35,51] & [23,41,53] \end{pmatrix}$$

Secondly, calculate the weight of triangular fuzzy number. According to formula 5, we can calculate the comprehensive score of each expert on each index, expressed by matrix $\mathcal{Z} = (z_{ij})_{4 \times 4}$.

$$z_{ij} = \frac{(a_{ij} + 4 \times b_{ij} + c_{ij})}{6} \quad (5)$$

In the matrix \mathcal{Z} , for index of I, a_{ij} , b_{ij} and c_{ij} respectively represent the most conservative, most likely and most optimistic scores of expert J, and $i=1,2,3,4$, $j=1,2,3$. On the basis of formula 6, triangular fuzzy weight set $\beta = (\beta_1, \beta_2, \beta_3, \beta_4)^T$ can be calculated.

$$\beta_i = \mathcal{P}_i / \sum_i^n \mathcal{P}_i \quad (6)$$

In the formula 6, the value of n is 4, and $i=1, 2, 3, 4$.

Thus, the triangular fuzzy weight set β can be obtained, and β is $(0.2502, 0.2497, 0.2501, 0.2500)^T$.

(3) Triangular fuzzy entropy combination weighting

Triangular fuzzy entropy combination weighting is to combine entropy weight α and triangular fuzzy weight β , and calculate the combination weight of each index. The calculation formula is as follows:

$$\omega_i = \alpha_i \times \beta_i / \sum_{i=1}^n (\alpha_i \times \beta_i) \quad (7)$$

In the formula 7, the value of n is 4.

Therefore, according to formula 7, we can calculate the combined weight ω about the indicators of green ecology Y1, openness and stability Y2, sharing and harmony Y3, coordinated development Y4, and we obtain $\omega = (0.3251, 0.1726, 0.3449, 0.1574)^T$.

Similarly, the paper obtains the combination weight of other indicators, as shown in TABLE III.

TABLE III. Index combination weight

PRIMARY INDEX	SECONDARY INDEX	SECONDARY INDEX WEIGHT	TERTIARY INDEX	TERTIARY INDEX WEIGHT
KNOWLEDGE INNOVATION x	Innovation input x_1	0.5025	Capital input level x_{11}	0.4982
			Labor input level x_{12}	0.5018
	Innovation output x_2	0.4975	Patent authorization level x_{21}	0.5025
			Transformation level of innovation achievements x_{22}	0.4975
HIGH-QUALITY ECONOMIC DEVELOPMENT y	Green ecology y_1	0.3251	Exhaust emission y_{11}	0.0851
			Wastewater discharge y_{12}	0.2570
			Solid waste output y_{13}	0.0436
			Air quality level y_{14}	0.1773
			Greening level y_{15}	0.1195
			Industrial energy consumption y_{16}	0.3175
	Openness and stability y_2	0.1726	Level of foreign capital introduction y_{21}	0.3011

PRIMARY INDEX	SECONDARY INDEX	SECONDARY INDEX WEIGHT	TERTIARY INDEX	TERTIARY INDEX WEIGHT
			International trade level y_{22}	0.5049
			Attract international tourism level y_{23}	0.1940
	Sharing and harmony y_3	0.3449	Individual GDP level y_{31}	0.2626
			Educational input y_{32}	0.0331
			Number of beds in medical institutions y_{33}	0.1024
			Number of doctors in medical institutions y_{34}	0.3589
			Social security and employment input y_{35}	0.0814
			Medical and health input y_{36}	0.1616
	Coordinated development y_4	0.1574	Income gap between urban and rural areas y_{41}	0.4982
			Rationality of industrial structure y_{42}	0.5108

V. DATA PROCESSING AND HYPOTHESIS VERIFICATION

In recent years, with the goal of innovation driven high-quality economic development, Anhui Province has achieved fruitful results and greatly improved its economic strength. In 2020, Anhui's GDP reached 3.87 trillion, ranking fourth in China. Based on this, this paper selects the data of 16 prefecture level cities in Anhui Province from 2013 to 2019 as a sample to explore the relationship between knowledge innovation and high-quality economic development. The data of relevant indicators of knowledge innovation and high-quality economic development of each city are from the statistical yearbook of Anhui Province and the statistical yearbook of each city.

5.1 Data Standardization

It can be seen from Table I that the dimensions and units of the three-level indicators are different. At the same time, there are positive and negative attributes of each indicator. It is better when the value of the positive indicator is larger, and while the value of the negative indicator is smaller. In order to eliminate the

differences in dimensions and units between indicators and ensure the consistency of positive and negative indicators, that is, to ensure that the value of negative indicators is changed as large as possible, this paper uses the standardized formula of positive and negative indicators ^[25] to standardize the collected sample data. The formulas are as follows:

$$c_{ij} = \frac{(v_{ij} - \min_{1 \leq i \leq n}(v_{ij}))}{(\max_{1 \leq i \leq n}(v_{ij}) - \min_{1 \leq i \leq n}(v_{ij}))} \quad (8)$$

$$c_{ij} = \frac{(\max_{1 \leq i \leq n}(v_{ij}) - v_{ij})}{(\max_{1 \leq i \leq n}(v_{ij}) - \min_{1 \leq i \leq n}(v_{ij}))} \quad (9)$$

In the formula 8 and 9, v_{ij} refers to the data of three-level indicators, c_{ij} represents the standardization results of the corresponding three-level indicator data. Formula 8 is used for the standardization of positive indicators and formula 9 is used for the standardization of negative indicators.

5.2 Hypothesis Verification

Hypothesis I verifies that knowledge innovation has a positive impact on high-quality economic development. For knowledge innovation and high-quality economic development, this paper uses the comprehensive index of corresponding indicators, and the comprehensive index of indicators is calculated by weighted average of indicators. Then, with the help of SPSS 19.0 software, the article uses linear regression analysis to test hypothesis I. The results are shown in TABLE IV.

TABLE IV. The results of Hypothesis 1 verification

MODEL	INDEPENDENT VARIABLE	COEFFICIENT	R ²	SIG.
I	Knowledge Innovation	.409	.217	.000

Note: the dependent variable is high-quality economic development

According to table IV, in the regression analysis of the independent variable: knowledge innovation to the dependent variable: high-quality economic development, the independent variable coefficient is 0.409 and the significance test level is 0.000, indicating that knowledge innovation can significantly promote high-quality economic development, that is, Hypothesis I is verified.

Similarly, the test results of models II, III, IV and V can be obtained, as shown in TABLE V.

TABLE V. Model test results

MODEL	dependent variable	INDEPENDENT VARIABLE	COEFFICIENT	R ²	SIG.
II	Green ecology	Innovation input	.049	.129	.007
		Innovation output	.227		.027
III	Openness and stability	Innovation input	.107	.151	.023
		Innovation output	.402		.000
IV	Sharing and harmony	Innovation input	.478	.517	.000
		Innovation output	.331		.000
V	Coordinated development	Innovation input	.252	.254	.001
		Innovation output	.877		.000

In TABLE V, the coefficients of independent variables innovation input and innovation output of model 2 are 0.049 and 0.227 respectively, and the significance test level is less than 0.05. Therefore, innovation input and innovation output are significantly positively correlated with green ecology, and hypothesis II is verified. In model III, the maximum significance level of innovation input and output is 0.023, less than 0.05, and their coefficients are positive. Therefore, innovation input and innovation output play a positive role in promoting openness and stability. Hypothesis III is verified. In model IV, in the regression analysis of innovation input and innovation output on sharing harmony, both coefficients are greater than 0, and the significance test level is 0.000. Therefore, it can be considered that innovation input and innovation output have a positive impact on sharing harmony, and Hypothesis IV is verified. Finally, in model V, the coefficients of innovation input and innovation output are 0.252 and 0.877 respectively, which are positive numbers, and the significance test levels are 0.001 and 0.000 respectively, which are less than 0.01. Therefore, it can be concluded that hypothesis V holds that both knowledge innovation input and output have a significant positive impact on coordinated development.

To sum up, all the hypothesis made in the article have been verified, and the verification results are summarized in TABLE VI.

TABLE VI. Summary of hypothesis verification results

SERIAL NUMBER	HYPOTHETICAL CONTENT	VERIFICATION RESULTS
HYPOTHESIS I	Knowledge innovation has a significant positive impact on high-quality economic development	Hypothesis established
HYPOTHESIS II	Both input and output of knowledge innovation have a significant positive impact on green ecology.	Hypothesis established
HYPOTHESIS III	Both input and output of knowledge innovation have a significant positive impact on openness and stability.	Hypothesis established
HYPOTHESIS IV	Both input and output of knowledge innovation have a significant positive impact on Sharing and harmony.	Hypothesis established
HYPOTHESIS V	Both input and output of knowledge innovation have a significant positive impact on coordinated development.	Hypothesis established

VI. CONCLUSION AND ENLIGHTENMENT

6.1 Conclusion

This paper aims to explore whether knowledge innovation plays a significant role in promoting high-quality economic development. Firstly, this paper makes a theoretical analysis on the role of knowledge innovation in promoting high-quality economic development, puts forward research hypotheses, and establishes relevant research models. Then, combined with the new development concept, this paper constructs the relevant research index system according to the research results of existing scholars. Then, the triangular fuzzy entropy weighting method is used to comprehensively weight the indicators of knowledge innovation and high-quality economic development. Finally, based on the statistical yearbook of Anhui Province and the statistical yearbook of various cities in Anhui Province, the relevant data of 16 cities in Anhui Province from 2013 to 2019 are taken as samples, and the assumptions and models are verified with the help of linear regression analysis. The results show that: (1) knowledge innovation is the basis of innovation activities, and innovation driven development mode should pay attention to knowledge innovation. (2) On the whole, in the regression analysis model of knowledge innovation and high-quality economic development, the knowledge innovation coefficient is positive and has a significant impact, indicating that the stronger the knowledge innovation is, the more it can significantly promote the improvement of high-quality economic development level. (3) From the sub dimensions of knowledge innovation and high-quality economic development, each dimension of knowledge innovation: innovation input and innovation output have a significant positive role in promoting the key indicators of high-quality economic development: green ecology, openness and stability, sharing and harmony, coordinated development, etc., but there are differences in the level of relevant promotion (there are differences in the coefficient of relevant variables in the regression model). It shows that there are obvious differences in the influence degree of knowledge innovation input and output on each dimension of high-quality economic development, and there are also great differences in the influence degree of knowledge innovation input and output for a certain dimension of high-quality economic development. For example, for coordinated development, the influence coefficient of knowledge innovation output 0.877 is significantly greater than that of knowledge innovation input 0.252. (4) According to the new development concept, high-quality economic development can be measured from the dimensions of green ecology, openness and stability, shared harmony and coordinated development, but these dimensions have different contributions to the measurement of high-quality economic development (the weights of each dimension are different), in which shared harmony contributes the most and coordinated development contributes the least. To sum up, whether from the whole or part, knowledge innovation can significantly promote high-quality economic development, but in part, there are differences in the intensity of knowledge innovation in promoting high-quality economic development. At the same time, when measuring the high-quality economic development, there are differences in the contribution of different measurement dimensions.

6.2 Enlightenment

According to the research results, we can draw the following enlightenment: (1) pay attention to knowledge innovation and help innovation driven development. The root of all innovation, especially basic innovation, can be attributed to knowledge innovation. The high-quality economic development mode driven by innovation should pay attention to the driving role of knowledge innovation, increase the input in knowledge innovation, increase the input in innovative elements such as funds, talent training and talent introduction, strengthen the output and transformation of innovation achievements, and lay a solid foundation for knowledge innovation to promote high-quality economic development. (2) Rely on knowledge innovation to jointly promote the development of high-quality economic links. Integrate the concept of knowledge innovation into high-quality economic development links such as green ecology, openness and stability, shared harmony and coordinated development, give full play to the driving role of innovation, focus on establishing innovation mechanism and carrying out the transformation and application of innovation achievements according to the core work of each link. (3) Grasp the relationship between the whole and part, and promote high-quality economic development in a focused and all-round way. High quality economic development is a complex systematic project. While promoting high-quality economic development in an all-round way, paying attention to key work and key links is conducive to promoting high-quality and rapid economic development and improving the level of high-quality economic development.

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