sustainability

MDPI

Article

Empirical Study on Human Capital, Economic Growth and Sustainable Development: Taking Shandong Province as an Example

Sujuan Wang [1], Xiaonan Lin [1], Honggen Xiao [2], Naipeng Bu [1,*] and Yanan Li [3]

[1] Business School, Shandong University, Weihai 264209, China; wsj@sdu.edu.cn (S.W.); 202017184@mail.sdu.edu.cn (X.L.)
[2] School of Hotel and Tourism Management, Hong Kong Polytechnic University, Hong Kong, China; honggen.xiao@polyu.edu.hk
[3] School of Innovation and Management, Suan Sunandha Rajabhat University, Bangkok 10300, Thailand; s64584945052@ssru.ac.th
* Correspondence: bunp@sdu.edu.cn

Abstract: This study aims to explore the sustainable development of the regional economy from the perspective of human capital. Based on the panel data from 2005 to 2019 in Shandong Province, China, this study first analyzes the interactive coupling mechanism between human capital and sustainable economic growth, and then constructs the evaluation model of coupling coordination degree. Results reveal that Shandong Province's human capital and sustainable economic growth gradually increased; the coupling coordination degree of human capital and sustainable economic growth changed from a state of mild imbalance to slight coordination; sustainable economic growth lagged human capital development; education scale, innovation capacity, growth level, economic openness, and investment and consumption level are the key factors affecting sustainable economic development. Through the above research, the study puts forward policy suggestions conducive to sustainable development in China.

Keywords: human capital; economic growth; sustainable development; China

Citation: Wang, S.; Lin, X.; Xiao, H.; Bu, N.; Li, Y. Empirical Study on Human Capital, Economic Growth and Sustainable Development: Taking Shandong Province as an Example. *Sustainability* **2022**, *14*, 7221. https://doi.org/10.3390/su14127221

Academic Editor: Antonio Boggia

Received: 21 April 2022
Accepted: 8 June 2022
Published: 13 June 2022

1. Introduction

The advent of the fourth industrial revolution and digital transformation has subsequently increased the demand for an eco-friendly economy, clean sources of energy, expanding the effects of financial development, and liberalized trade on renewables [1]. China is undergoing profound changes in the economic growth model, gradually moving from a stage of rapid growth to a stage of high-quality development. Along with this improvement, the "Lewis First Turning Point" is approaching, the resource-based demographic dividend is declining, and the labor-intensive and low-level extensive economic growth mode is no longer sustainable. To achieve a sustainable and deepening development of the Chinese economy, finding a new growth momentum and growth mode is necessary [2]. A consistent and multi-stage progress of sustainable economy allows for the protection the society from crises of overproduction and underconsumption, increasing the social well-being [3]. With the gradual deepening of people's understanding of human capital in recent years, human capital has played an increasingly important role in the quality change, efficiency change, and power change of economic growth. Human capital has become an important driving force for endogenous economic growth and a new engine for unleashing economic vitality. Therefore, how to further increase human capital stock and optimize human capital structure to promote high-quality and sustainable economic growth has become an urgent problem to be solved. At the same time, with the continuous optimization of the industrial structure and the continuous promotion of reform and innovation, sustainable economic growth presents a new pattern which provides new opportunities for cultivating high-quality human capital, promoting human capital accumulation, and increasing its value. Human capital and sustainable economic growth have a mutual influence. Human capital prepares and empowers high-quality and sustainable economic growth, whereas high-quality and sustainable economic growth provides an important guarantee for the improvement of human capital quality and level. Only when the two match and promote each other can they make concerted efforts and achieve "win-win" development outcomes. Therefore, whether human capital development is synchronized with high-quality and sustainable economic growth, whether sustainable economic growth is matched with human capital demand, and how to achieve a win-win situation are worthy of further research and exploration.

Previous studies on human capital and sustainable economic growth mainly considered the causal relationship between them, focusing on the one-way impact of human capital stock on sustainable economic growth [4]. In recent years, research on the dynamic relationship between the two has gradually attracted attention and achieved certain results, but most studies have explored the coupling coordination degree from the perspective of time and space. A few investigations have explored the coupling path of the two but have not yet revealed the "black box" between them. Moreover, research on the factors affecting coupling and coordination is lacking. Therefore, analyzing the coupling coordination relationship between human capital and sustainable economic growth, studying the coupling mechanism, and exploring the key factors that affect the coordination and efficiency of the two have important theoretical and practical significance for the enrichment and development of human capital and economic growth.

Shandong Province, as China's third largest economically underdeveloped province, has long carried a stereotype of being big, yet poor and weak. This creates an environment where young people are reluctant to stay for employment, leading to brain drain. Meanwhile, due to economic transformation and rising labor costs, its demographic dividend advantage is becoming weaker despite its large population. Recently, Shandong has promoted high-quality development, and the conversion of old to new power has increased speed and efficiency. A systematic reshaping of the quality structure, institutional mechanisms, and development environment has been gradually implemented. Economic development has demanded higher requirements for talent reserves.

Because of this, Shandong has made overall plans to promote employment and talent policy integration and innovation, improve the entry of new talent, emphasize the role of talent engineering and establish a talent training model. With the researchers being residents of Shandong, their warm-body experiences of the current talent pool, economic growth, and sustainable development of Shandong could prove beneficial in easing the study's collection of empirical data. Hence, this study selects Shandong Province as an example for subsequent analysis.

As far as Shandong Province is concerned, in recent years, on the one hand, new breakthroughs have been made in high-quality and sustainable economic growth; the environment for innovation and entrepreneurship has been continuously optimized; and the added value of the new economy, which is mainly characterized by new technologies, industries, business forms, and models, has been increasing in its proportion of the regional gross domestic product (GDP). On the other hand, teams comprising professional, skilled, and multilevel talents continue to grow, and human capital stock obtains incessant increase. However, some phenomena in Shandong Province, such as it being large but not powerful, unbalanced and with insufficient development, lack of talent, and inadequate human capital service, are still observed [5].

In this study, we aim to answer the question of how to effectively measure the temporal dimension changes of the coupling coordination degree between human capital and sustainable economic growth in Shandong Province. Specifically, we aim to find the key factors that influence the coupling coordination. To solve this problem, we build an evaluation index of human capital and sustainable economic growth. For calculating the relative weight of each criterion, we use a hybrid decision model known as the Gray-Decision-Making Trial and Evaluation Laboratory (gray-DEMATEL)-based Analytic Network Process (i.e., GDANP) developed by Jiang to avoid the tedious questionnaire of DEMATEL and help find the determinants of coupling coordination degree in Shandong Province. Moreover, the changes in the coupling coordination degree are obtained using the coupling coordination model. The remainder of this paper is organized as follows: Section 2 states the interaction between human capital and sustainable economic growth. Section 3 describes the methodology used in this study. Section 4 empirically investigates the temporal evolution characteristics of the coupled and coordinated development of human capital and sustainable growth on the basis of their development situation in Shandong Province from 2005 to 2019. It also effectively identifies the key factors. Lastly, Section 5 presents conclusions and suggestions.

2. Interaction between Human Capital and Sustainable Economic Growth

Human capital theory originated in the 1960s. After decades of speculation and continuous improvement, human capital has been widely accepted as the sum of the knowledge, skills, and health quality of laborers. Human capital stock can be continuously accumulated through investment in education and training, health care, immigration, and market information collected and obtained during the job hunting or trading process [6,7].

The evolution of human capital theory is closely related to mainstream economics research. Therefore, extensive research on the impact of human capital on sustainable economic growth has been carried out in recent years.

Current studies divide the impact of human capital on economic growth into two categories: One focuses on the positive impact of human capital on economic growth, widely recognized as the mainstream view. Scholars such as Sghaier and Imen argued that human capital accumulation in countries with high foreign direct investment would have a positive impact on economic growth [8]. Using data from 132 countries over 15 years, Ali et al. showed that human capital can play a positive role in per capita GDP growth in the presence of better economic opportunities and a high-quality legal system [9]. Deng and Long also confirm that innovative human capital is the main factor driving economic growth in eastern China through technological innovation by using panel data from 30 provinces. The effective allocation of skilled and innovative human capital promotes the economic growth in the central and western regions [10,11].

Other perspectives argue that there is no significant or even negative impact on economic growth. Vinod and Kaushik believed that in the neoclassical growth model, technological progress is the main driving factor for sustainable economic growth, and the accumulation of human capital is the main reason for promoting technological progress [12]. However, Zhang, re-established metrics for estimating China's human capital stock, analyzing Chinese statistics from 1978 to 2017. Moreover, Zhang found that the contribution of pure technological progress to economic growth in China is unremarkable, and economic growth mainly comes from factor contribution [13]. Benhabib and Spidgel found that the link between the increment of human capital and the growth rate of the output level is either moot or shows a negative relationship [4]. Filmer and Pritchett showed that average years of schooling were not significant in explaining different countries' economic growth rates [14]. In the context of human capital dynamics, Ma focused on panel data of 31 Provinces in China from 1995 to 2018 and proved that education human capital and the dependency ratio had a restraining effect on economic growth [15]. Wang et al. argued that, theoretically, economic servitization can promote human capital consumption, accelerate human capital accumulation, and then drive economic growth. The labor market in Hong Kong was weakened because of decreased domestic consumption and tourist spending [16]. However, limited by the inefficiency of human capital, the human capital accumulation effect of human capital enhancement consumption in China is weak and unable to offset the negative impact caused by the decreasing labor force [17].

Existing research mainly uses classical regression or production function model derivation methods, concentrating on the causal relationship between human capital and economic growth, namely the one-way impact of human capital on economic growth. The internal interaction mechanism of human capital and economic growth is seldom discussed. If the mutual effects between human capital and economic growth are ignored, then the driving effect of human capital on economic growth would be overestimated, and the engine function of human capital in economic growth cannot be truly and objectively reflected [18]. At present, studies on the relationship between the two mainly borrow the coupling concept in physics and construct the coupling coordination model to analyze the temporal and spatial variations of interaction between the two systems.

Existing research demonstrates the changes in the coupled coordination between human capital and regional sustainable economic growth from the time dimension, subdivides human capital, and verifies that heterogeneous human capital with increasing marginal effect plays a more obvious role in driving economic growth than homogeneous human capital with a decreasing marginal effect [19]. It confirms the coupling relationship between healthy human capital and the regional economic system and finds that the increase in healthy human capital stock promotes regional economic growth far greater than the spillover effect of regional economic growth on the accumulation of healthy human capital [20]. Some scholars have paid attention to the differences among regions, discussed the differences in the coupling relationship between human capital and economic growth among provinces, and measured and analyzed the coupling characteristics of the two. The results show that the degree of mutual influence between human capital and economic growth in various provinces in China is still low. Moreover, an increasing trend from west to east is observed, with coupling and convergence among regions [21]. In the framework of distribution dynamics, with the Yangtze River Delta, the Pearl River Delta, Beijing–Tianjin–Hebei, Chengdu–Chongqing—the five urban agglomerations in the middle reach of Yangtze River—as the research sample, the coupling path of human capital and economic growth is formed, and the human capital and economic growth of the city coupling degree is improved; however, obvious dynamic inconsistency problems remain unaddressed, and regional economic growth plays a relatively limited role in promoting human capital investment [22]. Chen explored the mechanism of the high-quality coordinated development of the real economy and human resources [23]. Human resources are not only producers that support economic growth but also consumers that drive social domestic demand. Therefore, the mechanism of the high-quality coordinated development of sustainable economic growth and human resources is embodied on two levels: one is the organic connection between economic growth requirements and human resource supply; the other is the effective matching of market supply and consumer investment demand.

Previous results have revealed that an interaction mechanism exists between economic growth and human capital, that is, economic growth demand is organically connected with human capital supply. In addition, high-quality and sustainable economic growth accelerates the accumulation of human capital elements and the flow of human capital among regions and expands the market scale of human capital. Moreover, the continuous expansion of human capital quantity, the steady quality improvement, and the continuous structure optimization have injected a steady stream of vitality into the continuous economic growth. Human capital and sustainable economic growth promote each other and form a virtuous circle. First, in terms of quantity, high-quality and sustainable economic growth creates additional jobs, adequate innovation support, and favorable development opportunities for high-quality talents with new knowledge and skills; as a result, the market supply of human capital is maximized, and the flow and prosperity of human capital markets are promoted [24]. The increase of human capital stock improves the marginal productivity of individuals and slows down the decline of the marginal productivity of material capital [25]. When the improvement of the marginal productivity of individuals exceeds the decline of the marginal productivity of material capital, the output has an incremental effect which adversely affects sustainable economic growth. Second, from the perspective of quality, high-quality sustainable economic growth is inseparable from innovation drive and industrial structure optimization and upgrading in which human capital quality is the key factor. Sustainable economic growth puts forward new requirements on the supply capacity of human capital, and the demand of long-term and sustainable economic growth forces the improvement of the quality of human capital. Given the positive externality of human capital, the improvement of workers' personal skills and education levels has a spillover effect on social productivity, which further drives sustainable economic growth [26]. In addition, the introduction, imitation, absorption, and creation of technologies effectively promotes the effective convergence of talents, knowledge, technologies, and other innovative resources and elements; promotes collaborative innovation; and improves social productivity levels [27]. Third, in terms of structure, high-quality and sustainable economic growth accelerates the extension of consumption structures, such as education, health care, and entertainment, to service, thus promoting the accumulation of human capital elements and promoting the optimization of human capital structure [28]. Advanced industrial structure is an important representation of high-quality and sustainable economic growth. Theoretically, industrial structure should match with human capital structure. If a serious imbalance exists between the industrial and human capital structures, then the human capital structure lags behind sustainable economic growth, and meeting the new requirements of human capital under a new model and a new business form is difficult. As a result, material and technological capital cannot achieve the maximum utility and the improvement of production efficiency and high-quality and sustainable economic growth is hindered.

The effective matching between market supply and consumption and investment demand indicates that not only high-level consumption and investment demand of human capital can be satisfied through production but also the products and services created by human capital can make value realization come true through consumption. With production and consumption development, there exists a new dynamic circulation mechanism between human capital and sustainable economic growth. Shifting investment toward human capital can expand green transformation, improve labor force resilience, and contribute to a rise in human welfare [29]. Specifically, high-quality and sustainable economic growth not only provides better and richer products to meet the increasing consumption and investment needs of human capital, but also promotes purchasing power improvement as income accompanying sustainable economic growth increases. As the beneficiary of education investment, human capital is inclined to education investment and related fields. In promoting capital value realization, human capital drives high-quality and sustainable economic growth and improves investment structure, which, in turn, promotes high-quality human capital development and ultimately has a positive impact on sustainable economic growth [30].

Therefore, the key factors affecting the coordinated development of human capital and sustainable economic growth and to what extent the interaction between human capital and sustainable economic growth is the most significant must be further studied. This research takes Shandong Province as an example to discuss the coordination relationship and coupling mechanism between human capital and sustainable economic growth and to explore the key factors affecting the coordination and efficient function of the two, so that a balanced and sustainable development of human capital and sustainable economic growth is promoted.

3. Methodology

On human capital and economic growth, current academic research mainly adopts quantitative research methods such as FEM, REM, OLS, and GMM. [31] Applied OLS regression also illustrates a positive relationship between human capital, labor force, and absorptive capacity, which determines the spillover effect on Malaysian economic growth. Hye and QMA employed the autoregressive distributed lag (ARDL) approach to suggest the existence of a strong complementary relationship between human capital and the trade openness index given the rise of real GDP [32]. Using a mixed effect model with fixed and random effects highlighting the total impact of human capital [33] showed that innovation capacity indirectly influenced the improving economic growth of human capital. However, these research methods explore the correlation between explanatory variables and explained variables. Essentially, this means the ways in which the explanatory variables affect the explained variables. These traditional research methods can only explore the one-way effect of human capital on economic growth, but are not suitable for explaining the two-way link between human capital and economic growth. Moreover, traditional research methods tend to lead to overestimation of the "pulling effect" of human capital on economic growth.

Evaluating the development level of human capital and sustainable economic growth is a typical multiple-criteria decision-making (MCDM) problem. Thus, determining the competing criteria to be included in the human capital and sustainable economic growth evaluation structure is necessary. The GDANP method is a comprehensive MCDM technique based on Grey Relational Analysis (GRA), DEMATEL, Analytic Network Process (ANP), and Analytic Hierarchy Process (AHP). However, these methods present drawbacks which can be solved by GDANP; for example, AHP and ANP cannot handle negative values [34]. In addition, GDANP has been successfully used in supplier selection [35,36], two sector interaction [34], and regional intellectual capital evaluation [37]. Therefore, using GDANP to research the relationship between human capital and economic growth is the right step towards innovating research methods.

In Section 3.1, we describe the index system. In Section 3.2, we introduce the GDANP technique that is used to identify the critical factors. In Section 3.3, we describe the coupling coordination model, which is used to rank the human capital and sustainable economic growth levels of indexes in Shandong Province.

3.1. Construct Human Capital and Sustainable Economic Growth Index System

The influencing factors of human capital and sustainable economic growth are multidimensional and complex. Therefore, the evaluation of the human capital and sustainable economic growth system should adopt the method of multiple index comprehensive evaluation and determine the inner correlation between each index and each system. Considering the comprehensiveness of the system, the availability of data, and the scientific rigor of the analysis process, and referring to the academic research results on the coupling and coordinated development of human capital and sustainable economic growth, two systems of human capital and sustainable economic growth in Shandong Province are constructed, and 21 specific indicators are selected, as shown in Table 1.

3.2. GDANP

Before calculating the coupling coordination degree, evaluating the comprehensive development level of human capital and sustainable economic growth by using the index weights of their influencing factors is necessary. DEMATEL, ANP, AHP, and other methods are solutions to cope with MCDM, but each of these methods has its drawbacks. Ouyang proposed a hybrid model called DEMATEL-based ANP (DANP), which can prevent these troubles. In practice, DANP uses a direct influence matrix, which involves a number of items in the process of pairwise comparisons. The number of indicators not only determines the time required for respondents to fill in the direct influence matrix but also affects the quality of the questionnaires. Respondents must spend time dealing with complex indicators and tend to feel agitated, affecting the objectivity of answers. Therefore, Jiang developed a decision model, GDANP, which can avoid pairwise comparisons by automatically generating the direct influence matrix [34]. At present, the GDANP method has been successfully applied in development level assessment and two-department interaction.

Table 1. Human Capital and Sustainable Economic Growth Index System of Shandong Province.

System	Aspect	Criterion	Variable
Human capital	Education scale	Proportion of students in regular higher education institutions (+)	x_1
		Proportion of students in regular primary and secondary schools (+)	x_2
	Innovation capacity	Number of patent applications accepted (+)	x_3
		Technology market turnover (+)	x_4
		Research and development (R&D) expenditure (+)	x_5
	Cultural environment	Total number of public libraries and museums (+)	x_6
		Total number of newspaper prints (+)	x_7
		Television coverage rate (+)	x_8
	Life quality	Expenditure on education, culture, and entertainment per capita in urban areas (+)	x_9
	Medical health	Life expectancy (+)	x_{10}
		Number of doctors per 10,000 people (+)	x_{11}
		Number of medical beds per 10,000 people (+)	x_{12}
Sustainable economic growth	Growth level	GDP per capita (+)	x_{13}
	Industrial structure	Proportion of the added value of the primary industry (−)	x_{14}
		Proportion of the added value of the secondary industry (−)	x_{15}
		Proportion of the added value of the tertiary industry (+)	x_{16}
	Openness	Total import and export volume (100 million yuan) (+)	x_{17}
		Number of foreign capitals actually utilized (100 million Yuan) (+)	x_{18}
	Investment and consumption level	Loan balance per capita (Yuan) (+)	x_{19}
		Investment in fixed assets per capita (Yuan) (+)	x_{20}
		Consumption expenditure of urban residents per capita (Yuan) (+)	x_{21}

Note: "+" is a large indicator, "−" is a small indicator. The data come from the Shandong Statistical Yearbook and China Statistical Yearbook from 2005 to 2019.

The procedure of GDANP is as follows:

Step 1: Generating the direct influence matrix by gray relational analysis (GRA).

Gray relational coefficients (GRCs) are the bridges between data gathered from the Shandong Statistical Yearbook and the China Statistical Yearbook (from 2005 to 2019) and the direct influence matrix, that is, we must first calculate the GRC of each indicator. Let the reference sequence be $X_r = \{x_r(1), x_r(2), \ldots, x_r(n)\}$, and the comparison sequence be $X_c = \{x_c(1), x_c(2), \ldots, x_c(n)\}$. Then,

$$\xi(x_r(k), x_c(k)) = \frac{\underset{i}{\min}\underset{k}{\min}|x_r(k) - x_c(k)| + \rho\underset{i}{max}\underset{k}{max}|x_r(k) - x_c(k)|}{|x_r(k) - x_c(k)| + \rho\underset{i}{max}\underset{k}{max}|x_r(k) - x_c(k)|}, \text{ for } 1 \le i \le \text{n}, 1 \le k \le \text{ m}, \quad (1)$$

where ρ is the discriminative coefficient ($0 \le \rho \le 1$), which is usually set at 0.5.

Calculation of the gray relational grade (GRG) leads to the formula, as follows:

$$\text{z}(x_0(k), x_i(k)) = \sum_{i=1}^{n} w_i \xi(x_0(k), x_i(k)), \quad (2)$$

where $\sum_{i=1}^{n} w_i = 1$ $(0 \le w_i \le 1)$. w_i means the importance of attribute i, which we think is equally important.

The direct influence matrix can be calculated as follows:

$$Z = \begin{bmatrix} z(x_1, x_1) & z(x_1, x_2) & \cdots & z(x_1, x_n) \\ z(x_2, x_1) & z(x_2, x_2) & \cdots & z(x_2, x_n) \\ & \vdots & \ddots & \vdots \\ z(x_n, x_1) & z(x_n, x_2) & \cdots & z(x_n, x_n) \end{bmatrix} \quad (3)$$

Step 2: Generating the total influence matrix by DANP

In the direct influence matrix of DANP, the diagonal elements are zero. Z is then normalized to produce the normalized direct influence matrix. The total influence matrix T is represented by the following:

$$\boldsymbol{T} = X(1 - X)^{-1} \tag{4}$$

where

$$\lambda = \frac{1}{\underset{i,j}{max}\left\{max \sum_{i=1}^{n} z_{ij}, max \sum_{j=1}^{n} z_{ij}\right\}} \tag{5}$$

and

$$\boldsymbol{X} = \lambda \boldsymbol{Z} \tag{6}$$

Step 3: Calculating the prominence and relation of each attribute by DEMATEL.

D is the sum of the rows of the total influence matrix, and R is the sum of the columns of the total influence matrix. $D + R$ represents the prominence of each attribute. The higher the prominence, the greater impact of the indicator on the system. $D - R$ represents the degree of relation of each attribute. When the degree of relation is positive, the degree of influence of this attribute on other factors is great.

Step 4: Obtaining the relative weight of each criterion by DEMATEL.

The unweighted supermatrix T is transformed into a weighted supermatrix W through normalization. On this basis, each criterion in the matrix is multiplied by itself to the supermatrix W*.

3.3. Coupling Coordination Model

The coupling coordination model includes two models: coupling degree and coordinated development degree. Among them, coupling degree comes from the concept of physics and refers to the degree of mutual influence and interaction among systems. The closer the coupling degree is to 0, the lower the coupling degree, indicating that the system is in a disordered state and the degree of mutual influence is less. On the contrary, the closer the coupling degree is to 1, the higher the coupling degree, suggesting that the system is in an orderly state, and the greater the degree of mutual influence.

According to the w_{ij} by the limiting supermatrix W*, we calculate the comprehensive evaluation index U_i of each system. The formula is as follows:

$$U_i = x'_{ij} \sum_{j=1}^{p} w_{ij} \tag{7}$$

We draw on Du et al. and Jiang et al. to study the coupling relationship between human capital and the sustainable economic growth system [38,39]. The formula of coupling degree is as follows:

$$C = \left[\frac{U_1 \times U_2}{(U_1 + U_2)^2}\right]^{\frac{1}{2}} \tag{8}$$

In the equation above, U_1 and U_2, respectively, stand for the comprehensive evaluation indexes of human capital development level and sustainable economic growth level.

The coupling degree only reflects the degree of interaction between the two systems and does not reveal the differences in the development levels of the systems at different stages. When human capital and sustainable economic growth are both at low development levels, there can also be a high coupling degree. However, this high coupling degree is fundamentally different from a high-level, high-quality coupling. Therefore, constructing a coordinated development model of human capital and sustainable economic growth is still necessary. Li et al. and Duan et al. used the formula to assess the coordinated coupling degree [40,41]. The coordinated development degree formula used in this study is as follows:

$$CCD = \sqrt{C \times T} \tag{9}$$

$$T = \alpha U_1 + \beta U_2 \quad (10)$$

Among them, *CCD* is the coupling coordination degree, *C* is the coupling degree, *T* is the comprehensive development index of human capital and sustainable economic growth, and the undetermined coefficient $\alpha + \beta = 1$. Given that human capital and sustainable economic growth are equally important in this study, α and β are set to 0.5, and the coupling coordination degree between human capital and sustainable economic growth are divided into 10 levels [42], as shown in Table 2.

Table 2. Type of Coupling Coordination Degree.

CCD Value Interval	Coupling Coordination Type	Level Classification
$0 < CDD \leq 0.1$	Extreme imbalance	Germination stage
$0.1 < CDD \leq 0.2$	Severe imbalance	
$0.2 < CDD \leq 0.3$	Moderate imbalance	
$0.3 < CDD \leq 0.4$	Mild imbalance	
$0.4 < CDD \leq 0.5$	Little imbalance	Start stage
$0.5 < CDD \leq 0.6$	Barely coordination	
$0.6 < CDD \leq 0.7$	Primary coordination	Steady stage
$0.7 < CDD \leq 0.8$	Intermediate coordination	
$0.8 < CDD \leq 0.9$	Good coordination	Maturity stage
$0.9 < CDD \leq 1.0$	Excellent coordination	

The framework of the proposed hybrid model in this paper is shown as Figure 1.

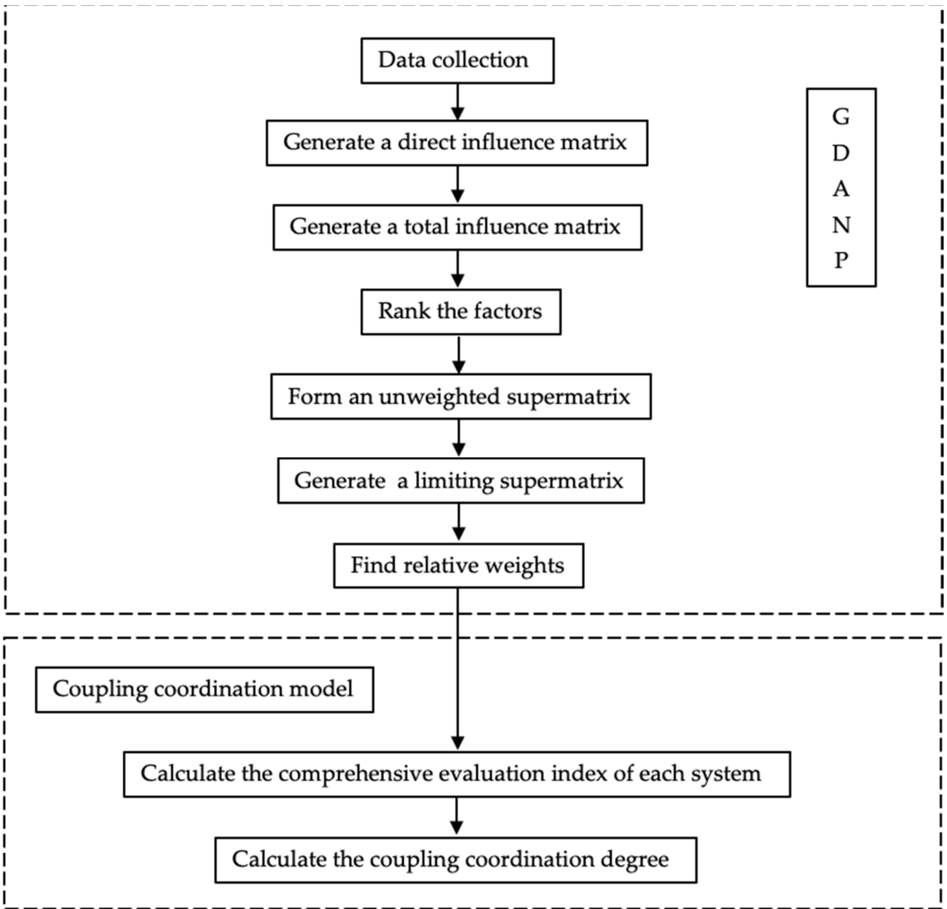

Figure 1. Empirical framework.

4. Empirical Analysis and Results

4.1. Dynamic Analysis of Coupling Coordination Degree

The relvevant data of Shandong province between 2005 to 2019 were sourced from the China Statistical Yearbook [43], and the calculation details are shown in Appendix A.

Using the above mathematical model, the comprehensive evaluation index of human capital, the comprehensive evaluation index of sustainable economic growth, and the coupling coordination degree in Shandong Province from 2005 to 2019 were calculated, as presented in Table 3, and drawn as a graph, as shown in Figure 2.

Table 3. Comprehensive Evaluation Index and Coupling Coordination Degree of Human Capital and Sustainable Economic Growth in Shandong Province from 2005 to 2019.

Year	Comprehensive Evaluation Index of Human Capital (U_1)	Comprehensive Evaluation Index of Sustainable Economic Growth (U_2)	Coupling Coordination Degree (CCD)
2005	0.2778	0.1905	0.3391
2006	0.2860	0.1996	0.3456
2007	0.2996	0.2139	0.3558
2008	0.3168	0.2187	0.3628
2009	0.3252	0.2248	0.3677
2010	0.3475	0.2524	0.3848
2011	0.3680	0.2800	0.4006
2012	0.3882	0.2968	0.4120
2013	0.4065	0.3244	0.4261
2014	0.4170	0.3433	0.4349
2015	0.4422	0.3583	0.4461
2016	0.4632	0.3823	0.4587
2017	0.4839	0.4064	0.4709
2018	0.5077	0.4101	0.4776
2019	0.5273	0.4202	0.4851

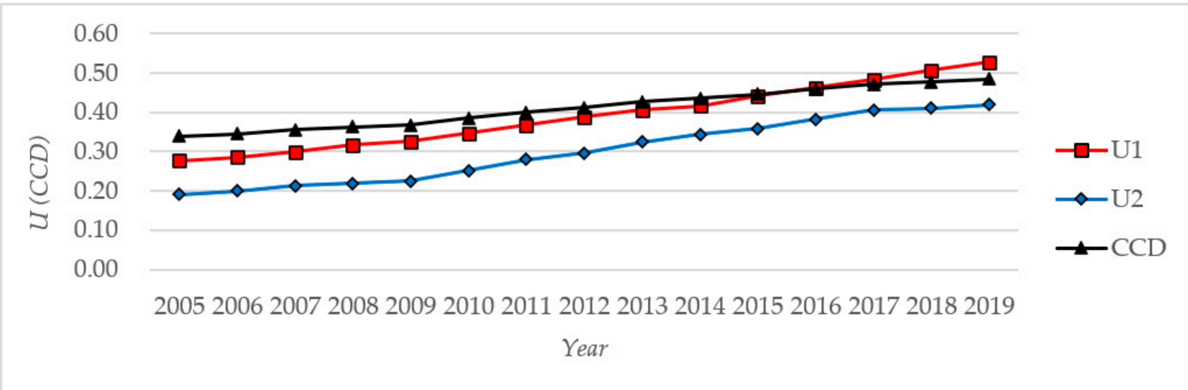

Figure 2. Changing trend of the comprehensive evaluation index of human capital and sustainable economic growth in Shandong Province and the coupling coordination degree.

Figure 1 illustrates the dynamic change trend of the comprehensive evaluation index and the coupling coordination degree of human capital and the sustainable economic growth system in Shandong Province, which are mainly manifested in the following characteristics:

(1) Human capital and sustainable economic growth continued to grow. The data demonstrate that the comprehensive evaluation index of human capital increased from 0.2778 to 0.5273 between 2005 and 2019, showing a continuous growth trend. The comprehensive index of sustainable economic growth increased from 0.1905 to 0.4202, and the growth rate increased significantly.

From 2005 to 2009, the comprehensive evaluation index of human capital increased from 0.2778 to 0.3252. During this period, human capital grew rapidly in terms of the number of patent applications accepted, R&D expenditure, expenditure on education, culture and entertainment per capita in urban areas, number of doctors per 10,000 people, number of medical beds per 10,000 people, and especially the number of patent applications accepted. R&D expenditure increased most significantly, by a factor of approximately 2.4. As a result, Shandong's innovation ability, cultural environment, and medical care have become new areas of growth in the human capital system, thereby promoting human capital development. The sustainable economic growth level also improved, and the comprehensive evaluation index of sustainable economic growth increased from 0.1905 to 0.2248. However, during this period, the number of foreign capitals actually utilized in Shandong Province dropped significantly, and the total import and export volume fluctuated greatly, which slowed down the improvement of sustainable economic growth levels.

From 2010 to 2014, the comprehensive indexes of human capital and sustainable economic growth continued to grow, and the growth rate was greater than that of the previous five-year period. The comprehensive evaluation index of human capital increased from 0.3475 to 0.4170, and that of sustainable economic growth rose from 0.2524 to 0.3433.

From 2015 to 2019, the comprehensive evaluation index of human capital showed a trend of continuous rise at a faster speed, realizing a significant increase from 0.4422 to 0.5273. The comprehensive evaluation index of sustainable economic growth also increased from 0.3583 to 0.4202. Thus, human capital and sustainable economic growth tended to improve faster and better in Shandong Province.

(2) Sustainable economic growth had lagged behind human capital growth. The data prove that the comprehensive evaluation indexes of human capital and sustainable economic growth were in a state of growth. The prospects of human capital and sustainable economic growth also constantly improved between 2005 and 2019. However, an obvious gap was observed between the two. The comprehensive evaluation index of sustainable economic growth in Shandong Province was always lower than that of human capital development, and the gap between the two had widened.

Taking the period from 2005 to 2009 as an example, the number of patent applications accepted, technology market turnover, and R&D expenditure increased significantly, and were nearly two times higher than for the previous period. This resulted in the improvement in the vitality of science and technology innovation in Shandong Province and created human capital increment. In terms of the sustainable economic growth level, the added value of the secondary industry accounted for more than half, but the proportion of the added value of the tertiary industry rose slowly. In this case, Shandong Province was still constrained by the transformation of technological achievements and the improvement of labor productivity. The pulling effect of human capital on sustainable economic growth failed to reach the expected results, and the sustenance for sustainable economic growth remained limited. In conclusion, the developmental coordination and interaction between the two was not that strong. Providing a strong guarantee for sustainable economic growth was also difficult for human capital, thus restricting the further improvement of the coupling coordination between the two.

(3) The coupling coordination degree between human capital and sustainable economic growth had been gradually increasing over the 2005–2019 period. Figure 1 illustrates that the coupling coordination degree between human capital and sustainable economic growth in Shandong Province was gradually improving, and the overall level was in a state of continuous growth. In 2005, the coupling coordination degree was only 0.3391, indicating that human capital and sustainable economic growth in Shandong Province were mildly imbalanced. Since then, it has increased year by year. By 2019, the coupling coordination degree was 0.4851, reaching almost barely coordination. In addition, the development of the two went from the germination stage to the start stage. This change meant that not only human capital and sustainable economic growth had maintained high-level development, but also that the interaction between the two had deepened. On the one

hand, the investment and accumulation of human capital had been increasing the efficiency of sustainable economic growth, while on the other, the high-quality development of the economy promoted the continuous growth of human capital.

From 2005 to 2009, the coupling coordination between human capital and sustainable economic growth improved from 0.3391 to 0.3677. Although the coupling degree had changed, it was still in a state of mild imbalance, which revealed that the development between sustainable economic growth and human capital was very uncoordinated. No resonance effect formed a benign development. From 2010 to 2014, the coupling coordination degree of human capital and sustainable economic growth increased from 0.3848 to 0.4349. Mutual promotion between them was improving, and the driving effect of sustainable economic growth on human capital development had been improved. At the same time, the coupling coordination degree between the two had always been in a state of slight imbalance and but almost barely coordination. Moreover, the role of human capital in promoting economic growth remained limited, so forming a joint force to create new economic growth opportunities was difficult. From 2015 to 2019, the coupling coordination degree of human capital and sustainable economic growth rose from 0.4461 to 0.4851. According to the statistical yearbooks, as the government, society, and enterprises paid further attention to human capital investment and accumulation, human capital developed rapidly. The most prominent performance was the number of patent applications accepted. Technology market turnover, R&D expenditure, and the total number of public libraries and museums had doubled in the past five years. These measures gave full play to the huge development potential of the technology trading market, dredged the transformation chain, promoted the transfer and transformation of scientific and technological achievements, effectively enhanced and released the traction and enabling effect of scientific and technological innovation on industrial upgrading, and promoted the enhancement of the vitality of scientific and technological innovation and the continuous improvement of the endogenous power of sustainable economic growth in Shandong Province. The most notable changes in sustainable economic growth were the marked increase in GDP per capita, the adjustment of the industrial structure from the secondary industry to the tertiary industry, and the substantial increase in the total volume of imports and exports and consumption expenditure of urban residents per capita. At the same time, the improvement of the degree of openness and the level of investment and consumption had further expanded domestic demand and stimulated sustainable economic growth.

In short, from 2005 to 2019, due to the attention and promotion from all walks of life, Shandong Province issued the Implementation Plan for the Transformation and Upgrading of the Software and Information Technology Service Industry in Shandong Province (2015–2020), which further promoted the deep integration of human capital and high-tech industry. Human capital and sustainable economic growth levels were also constantly improved. The mutual influence between human capital and sustainable economic growth developed in a benign and healthy direction, and the win-win situation between sustainable economic growth and human capital development was realized effectively. On the one hand, human capital growth injected strong and abundant vitality into sustainable economic growth, constantly driving such growth; on the other hand, sustainable economic growth provided adequate capital sources and superior cultural environment support for human capital investment and accumulation. However, we cannot ignore that although the speed of human capital development in Shandong Province had obviously improved, the growth rate of sustainable economic growth had not been synchronized with such development. Sustainable economic growth was far behind human capital growth, and the coupling coordination degree of the two was low. The driving effect of human capital on sustainable economic growth had not been fully explored, and its effect on sustainable economic growth was still limited. Therefore, how to further exert the core competitiveness of human capital to promote sustainable economic growth, how to provide an improved environment and support for human capital development, and how to effectively enhance the coupling coordination degree of the two are important problems that Shandong Province should solve in the development of the transformation of new and old kinetic energy.

4.2. GDANP Analysis

To further clarify the factors affecting human capital and sustainable economic growth in Shandong Province, the mathematical model above was used to rank the indicators of human capital and sustainable economic growth in the province. The key factors affecting the interaction of human capital and sustainable economic growth in Shandong Province were also obtained, and are presented in Table 4.

Table 4. Ranking of Human Capital and Sustainable Economic Growth Indexes in Shandong Province.

Variable	*D*	*R*	*D* + *R*	*D* − *R*	DEMATAL	DANP	Total Ranking	System Ranking
x_1	8.0347	8.4765	16.5112	−0.4418	3	9	5	2
x_2	8.1027	7.7433	15.8461	0.3594	14	8	11	5
x_3	8.0070	7.9568	15.9638	0.0502	11	11	11	5
x_4	6.0175	5.8084	11.8259	0.2090	21	21	21	12
x_5	8.2728	8.2112	16.4840	0.0617	5	2	2	1
x_6	7.6148	8.2565	15.8713	−0.6418	13	17	16	8
x_7	7.1948	7.2051	14.3999	−0.0103	20	20	20	11
x_8	7.5692	7.2024	14.7717	0.3668	18	18	18	9
x_9	7.7156	8.4045	16.1201	−0.6889	8	16	14	7
x_{10}	7.5601	7.1883	14.7483	0.3718	19	19	19	10
x_{11}	7.8400	8.8452	16.6852	−1.0053	2	15	9	4
x_{12}	7.9592	8.8662	16.8254	−0.9069	1	12	6	3
x_{13}	8.3847	8.1217	16.5064	0.2630	4	1	1	1
x_{14}	7.9226	7.7933	15.7159	0.1293	15	13	15	8
x_{15}	8.1471	7.9467	16.0938	0.2003	10	6	8	5
x_{16}	8.0281	8.0698	16.0978	−0.0417	9	10	10	6
x_{17}	8.1610	8.1125	16.2735	0.0485	6	5	3	2
x_{18}	7.8935	7.5316	15.4251	0.3618	17	14	17	9
x_{19}	8.1222	7.5444	15.6666	0.5778	16	7	13	7
x_{20}	8.2444	7.7037	15.9481	0.5407	12	3	7	4
x_{21}	8.2159	8.0196	16.2355	0.1963	7	4	3	2

Table 4 displays that among the human capital system indicators, the key factors affecting the interaction between human capital and sustainable economic growth were R&D expenditure, the proportion of students in regular higher education institutions, the number of medical beds per 10,000 people, and the number of doctors per 10,000 people. Among the sustainable economic growth system indicators, the key factors affecting the interaction between the two systems were GDP per capita, total import and export volume, and the consumption expenditure of urban residents per capita.

As for the human capital system, the data in Table 4 reveal that R&D expenditure had the most significant effect on the coordinated development of human capital and sustainable economic growth. R&D expenditure provided financial support for scientific and technological R&D and increased investment in human capital while science and technology progress promoted production efficiency improvement, which inevitably improved the economic benefit, thus affecting the improvement of the coordination between human capital and sustainable economic growth. The proportion of students in regular higher education institutions also had a significant effect on the coordinated development of the two. That is, additional high-quality professional talents and high-quality human capital was saved for sustainable economic growth. At the same time, students in regular higher education institutions could constantly incubate technological achievements that promoted scientific and technological progress and production development and promoted sustainable economic growth to improve the coordinated development of the two. The number of doctors per 10,000 people and the number of medical beds per 10,000 people represented the improvement of the level of medical care, which was a manifestation of sustainable economic growth; both indicators also suggested the improvement of the health population, thus further enriching human capital stock for health.

Regarding the economic system, GDP per capita increased, which meant that the sustainable economic growth level was improving significantly. As residents became richer, they were more willing to invest in their physical and spiritual health, thus promoting the improvement of human capital quality. Total import and export volume and the consumption expenditure of urban residents per capita were also key factors affecting the interaction of the two systems. Correspondingly, citizens were more willing to invest in their own health, cultural entertainment, knowledge training, and other areas, which would inevitably promote the development of human capital stock and quality. From the perspective of demography, Shandong Province has the characteristics of a large population base that is aging, with a small number of young people engaged in high-tech and serious brain drain. Therefore, high GDP per capita, the consumption expenditure of urban residents per capita, and R&D expenditure can provide guarantees for the improvement of human capital stock. The increase in the number of skilled personnel and the number of medical beds in health institutions represents the improvement in the level of medical care, which is conducive to alleviating the aging population problem, optimizing the population structure, and reducing the social burden. The improvement of human capital stock eventually promotes the continuous improvement of sustainable economic growth levels.

The systematic factors affecting the interaction between human capital and sustainable economic growth are diversified. Only by identifying the key factors and adopting scientific and effective measures and methods to improve the factor level can the coupling coordination degree of human capital and sustainable economic growth be truly improved to the point that they finally promote their joint development.

5. Conclusions and Suggestions

5.1. Conclusions

This paper constructs the evaluation index system of human capital and sustainable economic growth, selects the statistical data of Shandong Province from 2005 to 2019, uses the coupling coordination degree model to analyze the interaction between human capital and sustainable economic growth in Shandong Province in the past 15 years, uses gray-DANP to analyze the influencing factors of their coordinated development, and draws the following conclusions:

Human capital and sustainable economic growth in Shandong Province had achieved sustainable growth. Their comprehensive evaluation indexes from 2015 to 2019 showed a trend of continuous rise and steady growth at a fast speed. Human capital and sustainable economic growth in Shandong Province were still in a state of imbalance, but experienced the transition from the germination stage to the start stage. A significant gap was found between human capital and sustainable economic growth, and the speed of sustainable economic growth lagged behind that of human capital. In addition, the research demonstrated that R&D expenditure, the proportion of students in regular higher education institutions, the number of medical beds per 10,000 people, the number of doctors per 10,000 people, GDP per capita, total import and export volume, and consumption expenditure of urban residents per capita were the key factors affecting the coupling and coordinated development of human capital and sustainable economic growth.

This study presents some limitations. Evidently, there is a lack of support from the other 33 provinces, and only Shandong province has been selected for the study. The research in this field should draw from other sample sources in the future. Moreover, due to insufficient domestic statistical data, many plausible criteria are not applied in this study. Furthermore, this study was unable to include an in-depth analysis of the relationship between human capital and sustainable economies and clean energy. In future endeavors, this will provide a reference for future research, such as the discussion of the relationship between the human capital and green innovation.

5.2. Suggestions

The study puts forward the following suggestions to promote the healthy and sustainable economic growth of Shandong Province, China. The above empirical analysis shows that scientific and technological innovation achievements play a significant role in promoting the coupling and coordination of human capital and sustainable economic growth, whereas the current transformation efficiency of scientific and technological achievements restricts further sustainable economic growth. Therefore, scientific and technological innovation should focus on the national strategy and the frontier of science and technology, strengthen the regional characteristics of Shandong Province, deeply cultivate the needs of industrial structure adjustment, further enhance the service support ability for the industrial development, and actively meet the needs of economic and social development in Shandong Province. The patent application acceptance and incentive system, including the patent R&D capabilities, needs to be improved. Our results show that the number of patent applications accepted has a particularly significant impact on human capital development. The Shandong provincial government should attach great importance to intellectual property work, focus on the goal of creating a strong provincial project, implement the "Implementation Opinions on the National Intellectual Property Strategy Outline," improve the patent award system, vigorously encourage and support enterprises to invent and create patents, and stimulate enterprises. It must also encourage enthusiasm for innovation, promote the continuous growth of patent application, authorization, and ownership in Shandong Province, create a business environment for the harmonious development of science and technology, economy, and society, promote enterprise transformation, and promote the optimization of the industrial structure in Shandong Province. At the same time, it should accelerate the transformation of patent achievements; encourage and promote the transformation and application of patent achievements by patent licensing, technology transfer, technology investment, and other methods, and strengthen the role of enterprises in patent creation and application.

The expenditure of scientific research funds must be increased, the allocation efficiency of human capital must be improved, and new momentum for sustainable economic growth must be created. The Province must increase investment in training, promote high-quality human capital stock, alleviate the bottleneck of the shortage of high-quality human capital, especially innovative human capital in Shandong Province, improve the legal and institutional environment for R&D activities, improve the market system that promotes the rational flow of R&D funds and R&D manpower, and promote the deep integration of capital and labor markets. The quantitative demographic dividend is seriously declining, and providing sufficient reserve resources for human capital cultivation and development is difficult in Shandong Province. Therefore, attaching equal importance to human capital quality, expanding the scale of high-quality human capital, increasing the quantity of human capital, realizing the organic connection between sustainable economic growth requirements and human capital supply, and supporting economic and social development is necessary. It is also necessary to cultivate high-quality human capital, pay attention to the development of human capital services, increase investment in basic construction, and promote the industrialization of human capital services. It is better to innovate the human capital service system, build a human capital service industrial park, promote the standardization of human capital services, improve the efficiency of human capital market flow, innovate the human capital governance system, and implement the talent training mechanism that combines education and training. The Government needs to build a bridge for the talent flow among the government, enterprises, and universities, promote the all-round connection and deep integration of production, education, and research, and drive new incentives for sustainable economic growth. Meanwhile, health is an important part of human capital. Therefore, increasing investment in healthy human capital, improving the construction of medical and health care institutions in Shandong Province, raising awareness of medical treatment and medical care, improving the health status of residents, and increasing healthy human capital stock are necessary.

The adjustment of the industrial structure aims to increase the proportion of the tertiary industry and meet the new demands of human capital for consumption and investment in cultural, educational, sports, and entertainment fields. This kind of consumption investment itself is an investment method of human capital which can continue to promote human capital cultivation and accumulation and the benign interaction and linkage development between sustainable economic growth and human capital. Therefore, future industrial restructuring should also pay additional attention to people's growing material and cultural needs, focus on key areas related to people's livelihood and well-being, and develop high-tech industries, service industries, cultural, educational, sports, and entertainment industries, and the health and social security industries.

Author Contributions: Investigation, X.L., H.X., N.B. and Y.L.; Methodology, S.W. and X.L.; Project administration, H.X. and Y.L.; Resources, S.W. and X.L.; Supervision, X.L.; Validation, Y.L.; Writing—original draft, S.W.; Writing—review & editing, N.B. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by Social Science Foundation of Shandong Province, grant number 20CJJJ31.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

According to Equations (1)–(3), the initial direct influence matrix can be generated by GRA, and the initial direct influence matrices are shown in Table A1.

Following the DEMATEL method, the normalized direct influence matrix is presented in Table A2.

Given that $T = X\ (I - X)^{-1}$, the total influence matrices for ρ = 0.5 are shown in Table A3.

Table A4 displays the limiting super matrices derived from the weighted super matrices for ρ = 0.5. Table A5 shows the overall and intra-system rankings for factors, arranged in the ascending order of the Borda score of each factor.

According to Equations (8)–(10), Table A6 displays the coupling degree (*C*), the comprehensive development index of human capital and sustainable economic growth (*T*), and the coupling coordination degree (*CCD*).

Table A1. Initial Direct Influence Matrix (ρ = 0.5).

	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}	x_{11}	x_{12}	x_{13}	x_{14}	x_{15}	x_{16}	x_{17}	x_{18}	x_{19}	x_{20}	x_{21}
x_1	0.0000	0.7866	0.5859	0.4248	0.6317	0.6205	0.7227	0.6927	0.6327	0.6912	0.7459	0.7832	0.6624	0.8677	0.8600	0.8422	0.7179	0.6882	0.5359	0.5883	0.5948
x_2	0.8250	0.0000	0.5895	0.4470	0.6327	0.6123	0.7783	0.8720	0.6171	0.8734	0.6987	0.7233	0.6758	0.7641	0.7676	0.7524	0.6941	0.6731	0.5796	0.6226	0.6205
x_3	0.6322	0.5770	0.0000	0.6733	0.8740	0.8480	0.5500	0.5327	0.8380	0.5314	0.7441	0.7132	0.6673	0.5543	0.6006	0.6050	0.6693	0.5828	0.9037	0.7733	0.7787
x_4	0.4892	0.4478	0.6861	0.0000	0.6330	0.6262	0.4579	0.4295	0.6097	0.4292	0.5526	0.5401	0.4735	0.3999	0.4246	0.4315	0.4739	0.4326	0.5794	0.5252	0.5162
x_5	0.6739	0.6210	0.8738	0.6188	0.0000	0.7932	0.5609	0.5724	0.7843	0.5709	0.7679	0.7570	0.7561	0.6433	0.6234	0.6519	0.6628	0.6965	0.8294	0.8805	0.7680
x_6	0.6126	0.5478	0.8138	0.5512	0.7490	0.0000	0.4927	0.5051	0.8834	0.5041	0.7515	0.7354	0.6839	0.5090	0.5306	0.5619	0.6758	0.5276	0.8003	0.7066	0.7846
x_7	0.7610	0.7680	0.5489	0.4417	0.5603	0.5529	0.0000	0.7363	0.5857	0.7373	0.6418	0.6504	0.5342	0.6744	0.6927	0.6466	0.5868	0.6391	0.4708	0.4815	0.5052
x_8	0.7467	0.8724	0.5467	0.4295	0.5860	0.5730	0.7481	0.0000	0.5731	0.9821	0.6380	0.6625	0.6077	0.6900	0.6775	0.6623	0.6125	0.6166	0.5210	0.5752	0.5550
x_9	0.6209	0.5449	0.8010	0.5304	0.7370	0.8817	0.5233	0.4975	0.0000	0.4965	0.7919	0.7536	0.6857	0.5049	0.5585	0.5742	0.7247	0.5625	0.7813	0.6930	0.8394
x_{10}	0.7444	0.8732	0.5441	0.4279	0.5834	0.5709	0.7481	0.9820	0.5709	0.0000	0.6351	0.6595	0.6073	0.6901	0.6781	0.6625	0.6121	0.6173	0.5216	0.5749	0.5557
x_{11}	0.7170	0.6144	0.6723	0.4486	0.6999	0.7294	0.5559	0.5417	0.7744	0.5398	0.0000	0.9130	0.7695	0.5951	0.6605	0.6969	0.7686	0.6700	0.5999	0.6009	0.7407
x_{12}	0.7639	0.6516	0.6429	0.4451	0.6946	0.7200	0.5739	0.5783	0.7410	0.5760	0.9158	0.0000	0.7706	0.6748	0.7144	0.7665	0.7945	0.6508	0.5599	0.6115	0.6781
x_{13}	0.7325	0.6558	0.6941	0.4940	0.7777	0.7732	0.5783	0.5950	0.7826	0.5926	0.8717	0.8692	0.0000	0.7156	0.6761	0.7229	0.7638	0.7474	0.6517	0.7844	0.8041
x_{14}	0.8949	0.7246	0.5561	0.3929	0.6453	0.5967	0.6898	0.6537	0.6042	0.6516	0.7296	0.7794	0.7058	0.0000	0.8673	0.8570	0.7099	0.7128	0.5007	0.6218	0.5651
x_{15}	0.8911	0.7316	0.6067	0.4230	0.6300	0.6172	0.7117	0.6441	0.6491	0.6426	0.7718	0.8032	0.6855	0.8789	0.0000	0.8872	0.7527	0.7315	0.5768	0.5907	0.6419
x_{16}	0.8685	0.7056	0.5972	0.4149	0.6453	0.6324	0.6536	0.6146	0.6532	0.6126	0.7956	0.8386	0.7001	0.8482	0.8686	0.0000	0.7502	0.6855	0.5503	0.5864	0.6254
x_{17}	0.7685	0.6615	0.6804	0.4782	0.6754	0.7489	0.6148	0.5848	0.7936	0.5824	0.8634	0.8761	0.7457	0.7027	0.7293	0.7551	0.0000	0.6180	0.6464	0.6075	0.7600
x_{18}	0.7418	0.6312	0.5916	0.4326	0.7034	0.6250	0.6605	0.5837	0.6615	0.5824	0.7773	0.7594	0.7699	0.7516	0.7507	0.7418	0.6734	0.0000	0.5863	0.6922	0.6890
x_{19}	0.6397	0.5796	0.9220	0.6237	0.8597	0.8773	0.5416	0.5318	0.8648	0.5305	0.7649	0.7304	0.6880	0.5532	0.5992	0.6114	0.6956	0.5863	0.0000	0.8253	0.8163
x_{20}	0.6790	0.6167	0.8072	0.5645	0.9004	0.8087	0.5448	0.5789	0.8000	0.5767	0.7693	0.7656	0.8022	0.6532	0.6046	0.6377	0.6571	0.6843	0.8190	0.0000	0.7719
x_{21}	0.6701	0.5931	0.7944	0.5313	0.7853	0.8507	0.5463	0.5366	0.8948	0.5352	0.8507	0.8032	0.7993	0.5719	0.6254	0.6459	0.7706	0.6510	0.7878	0.7447	0.0000

Table A2. Normalized Direct Influence Matrix (ρ = 0.5).

	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}	x_{11}	x_{12}	x_{13}	x_{14}	x_{15}	x_{16}	x_{17}	x_{18}	x_{19}	x_{20}	x_{21}
x_1	0.0000	0.0520	0.0388	0.0281	0.0418	0.0411	0.0478	0.0458	0.0419	0.0457	0.0493	0.0518	0.0438	0.0574	0.0569	0.0557	0.0475	0.0455	0.0355	0.0389	0.0393
x_2	0.0546	0.0000	0.0390	0.0296	0.0419	0.0405	0.0515	0.0577	0.0408	0.0578	0.0462	0.0479	0.0447	0.0505	0.0508	0.0498	0.0459	0.0445	0.0383	0.0412	0.0410
x_3	0.0418	0.0382	0.0000	0.0445	0.0578	0.0561	0.0364	0.0352	0.0554	0.0352	0.0492	0.0472	0.0441	0.0367	0.0397	0.0400	0.0443	0.0386	0.0598	0.0512	0.0515
x_4	0.0324	0.0296	0.0454	0.0000	0.0419	0.0414	0.0303	0.0284	0.0403	0.0284	0.0366	0.0357	0.0313	0.0265	0.0281	0.0285	0.0313	0.0286	0.0383	0.0347	0.0342
x_5	0.0446	0.0411	0.0578	0.0409	0.0000	0.0525	0.0371	0.0379	0.0519	0.0378	0.0508	0.0501	0.0500	0.0426	0.0412	0.0431	0.0438	0.0461	0.0549	0.0582	0.0508
x_6	0.0405	0.0362	0.0538	0.0365	0.0496	0.0000	0.0326	0.0334	0.0584	0.0333	0.0497	0.0486	0.0452	0.0337	0.0351	0.0372	0.0447	0.0349	0.0529	0.0467	0.0519
x_7	0.0503	0.0508	0.0363	0.0292	0.0371	0.0366	0.0000	0.0487	0.0387	0.0488	0.0425	0.0430	0.0353	0.0446	0.0458	0.0428	0.0388	0.0423	0.0311	0.0319	0.0334
x_8	0.0494	0.0577	0.0362	0.0284	0.0388	0.0379	0.0495	0.0000	0.0379	0.0650	0.0422	0.0438	0.0402	0.0456	0.0448	0.0438	0.0405	0.0408	0.0345	0.0381	0.0367
x_9	0.0411	0.0360	0.0530	0.0351	0.0488	0.0583	0.0346	0.0329	0.0000	0.0328	0.0524	0.0499	0.0454	0.0334	0.0369	0.0380	0.0479	0.0372	0.0517	0.0458	0.0555
x_{10}	0.0492	0.0578	0.0360	0.0283	0.0386	0.0378	0.0495	0.0650	0.0378	0.0000	0.0420	0.0436	0.0402	0.0457	0.0449	0.0438	0.0405	0.0408	0.0345	0.0380	0.0368

Table A2. *Cont.*

	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}	x_{11}	x_{12}	x_{13}	x_{14}	x_{15}	x_{16}	x_{17}	x_{18}	x_{19}	x_{20}	x_{21}
x_{11}	0.0474	0.0406	0.0445	0.0297	0.0463	0.0482	0.0368	0.0358	0.0512	0.0357	0.0000	0.0604	0.0509	0.0394	0.0437	0.0461	0.0508	0.0443	0.0397	0.0398	0.0490
x_{12}	0.0505	0.0431	0.0425	0.0294	0.0460	0.0476	0.0380	0.0383	0.0490	0.0381	0.0606	0.0000	0.0510	0.0446	0.0473	0.0507	0.0526	0.0431	0.0370	0.0404	0.0449
x_{13}	0.0485	0.0434	0.0459	0.0327	0.0514	0.0511	0.0383	0.0394	0.0518	0.0392	0.0577	0.0575	0.0000	0.0473	0.0447	0.0478	0.0505	0.0494	0.0431	0.0519	0.0532
x_{14}	0.0592	0.0479	0.0368	0.0260	0.0427	0.0395	0.0456	0.0432	0.0400	0.0431	0.0483	0.0516	0.0467	0.0000	0.0574	0.0567	0.0470	0.0472	0.0331	0.0411	0.0374
x_{15}	0.0590	0.0484	0.0401	0.0280	0.0417	0.0408	0.0471	0.0426	0.0429	0.0425	0.0511	0.0531	0.0454	0.0581	0.0000	0.0587	0.0498	0.0484	0.0382	0.0391	0.0425
x_{16}	0.0575	0.0467	0.0395	0.0274	0.0427	0.0418	0.0432	0.0407	0.0432	0.0405	0.0526	0.0555	0.0463	0.0561	0.0575	0.0000	0.0496	0.0454	0.0364	0.0388	0.0414
x_{17}	0.0508	0.0438	0.0450	0.0316	0.0447	0.0495	0.0407	0.0387	0.0525	0.0385	0.0571	0.0580	0.0493	0.0465	0.0482	0.0500	0.0000	0.0409	0.0428	0.0402	0.0503
x_{18}	0.0491	0.0418	0.0391	0.0286	0.0465	0.0413	0.0437	0.0386	0.0438	0.0385	0.0514	0.0502	0.0509	0.0497	0.0497	0.0491	0.0445	0.0000	0.0388	0.0458	0.0456
x_{19}	0.0423	0.0383	0.0610	0.0413	0.0569	0.0580	0.0358	0.0352	0.0572	0.0351	0.0506	0.0483	0.0455	0.0366	0.0396	0.0404	0.0460	0.0388	0.0000	0.0546	0.0540
x_{20}	0.0449	0.0408	0.0534	0.0373	0.0596	0.0535	0.0360	0.0383	0.0529	0.0382	0.0509	0.0506	0.0531	0.0432	0.0400	0.0422	0.0435	0.0453	0.0542	0.0000	0.0511
x_{21}	0.0443	0.0392	0.0526	0.0351	0.0519	0.0563	0.0361	0.0355	0.0592	0.0354	0.0563	0.0531	0.0529	0.0378	0.0414	0.0427	0.0510	0.0431	0.0521	0.0493	0.0000

Table A3. Total Influence Matrix ($\rho = 0.5$).

	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}	x_{11}	x_{12}	x_{13}	x_{14}	x_{15}	x_{16}	x_{17}	x_{18}	x_{19}	x_{20}	x_{21}	D
x_1	0.3690	0.3864	0.3822	0.2791	0.3963	0.3975	0.3591	0.3572	0.4048	0.3565	0.4313	0.4347	0.3949	0.3937	0.3999	0.4041	0.3980	0.3711	0.3613	0.3717	0.3859	8.0347
x_2	0.4237	0.3400	0.3853	0.2827	0.3993	0.4000	0.3653	0.3709	0.4068	0.3704	0.4315	0.4341	0.3985	0.3902	0.3971	0.4015	0.3993	0.3728	0.3667	0.3765	0.3902	8.1027
x_3	0.4064	0.3712	0.3455	0.2946	0.4108	0.4115	0.3463	0.3450	0.4172	0.3443	0.4300	0.4289	0.3941	0.3720	0.3815	0.3873	0.3937	0.3629	0.3841	0.3828	0.3969	8.0070
x_4	0.3066	0.2802	0.3028	0.1894	0.3077	0.3089	0.2633	0.2615	0.3126	0.2610	0.3230	0.3228	0.2947	0.2788	0.2854	0.2899	0.2943	0.2727	0.2830	0.2846	0.2944	6.0175
x_5	0.4213	0.3852	0.4113	0.2995	0.3679	0.4199	0.3575	0.3580	0.4259	0.3572	0.4442	0.4444	0.4112	0.3889	0.3946	0.4020	0.4050	0.3808	0.3903	0.4002	0.4077	8.2728
x_6	0.3873	0.3531	0.3796	0.2748	0.3859	0.3409	0.3276	0.3281	0.4022	0.3275	0.4119	0.4116	0.3780	0.3528	0.3606	0.3677	0.3770	0.3437	0.3619	0.3624	0.3804	7.6148
x_7	0.3782	0.3502	0.3438	0.2538	0.3546	0.3558	0.2809	0.3273	0.3636	0.3268	0.3846	0.3861	0.3500	0.3465	0.3535	0.3554	0.3530	0.3337	0.3230	0.3302	0.3439	7.1948
x_8	0.3945	0.3724	0.3597	0.2648	0.3727	0.3737	0.3428	0.2959	0.3798	0.3563	0.4022	0.4047	0.3708	0.3632	0.3687	0.3727	0.3709	0.3476	0.3413	0.3514	0.3630	7.5692
x_9	0.3925	0.3571	0.3831	0.2767	0.3897	0.4005	0.3333	0.3316	0.3516	0.3309	0.4192	0.4176	0.3826	0.3569	0.3666	0.3729	0.3844	0.3499	0.3648	0.3658	0.3880	7.7156
x_{10}	0.3939	0.3720	0.3592	0.2645	0.3721	0.3731	0.3424	0.3565	0.3792	0.2950	0.4016	0.4041	0.3704	0.3629	0.3683	0.3723	0.3705	0.3473	0.3410	0.3510	0.3627	7.5601
x_{11}	0.4046	0.3670	0.3800	0.2751	0.3924	0.3963	0.3407	0.3396	0.4054	0.3388	0.3755	0.4333	0.3931	0.3683	0.3788	0.3863	0.3927	0.3618	0.3582	0.3650	0.3871	7.8400
x_{12}	0.4131	0.3745	0.3831	0.2784	0.3972	0.4009	0.3466	0.3466	0.4086	0.3459	0.4382	0.3821	0.3983	0.3784	0.3874	0.3959	0.3995	0.3656	0.3604	0.3704	0.3883	7.9592
x_{13}	0.4305	0.3923	0.4048	0.2950	0.4214	0.4233	0.3632	0.3640	0.4306	0.3632	0.4560	0.4568	0.3686	0.3984	0.4031	0.4116	0.4162	0.3887	0.3837	0.3988	0.4145	8.3847
x_{14}	0.4198	0.3780	0.3756	0.2737	0.3922	0.3911	0.3528	0.3504	0.3980	0.3497	0.4251	0.4292	0.3926	0.3348	0.3956	0.4002	0.3927	0.3681	0.3547	0.3691	0.3793	7.9226
x_{15}	0.4298	0.3877	0.3884	0.2826	0.4013	0.4025	0.3627	0.3584	0.4110	0.3577	0.4384	0.4414	0.4013	0.3991	0.3509	0.4117	0.4051	0.3783	0.3684	0.3766	0.3937	8.1471
x_{16}	0.4229	0.3810	0.3828	0.2784	0.3970	0.3982	0.3545	0.3519	0.4059	0.3512	0.4342	0.4378	0.3970	0.3922	0.4001	0.3511	0.3998	0.3707	0.3621	0.3715	0.3877	8.0281
x_{17}	0.4225	0.3834	0.3942	0.2868	0.4051	0.4117	0.3568	0.3548	0.4210	0.3540	0.4448	0.4464	0.4057	0.3884	0.3968	0.4039	0.3584	0.3717	0.3739	0.3786	0.4020	8.1610
x_{18}	0.4089	0.3706	0.3771	0.2755	0.3948	0.3920	0.3494	0.3445	0.4006	0.3439	0.4267	0.4266	0.3954	0.3804	0.3869	0.3916	0.3892	0.3218	0.3592	0.3725	0.3859	7.8935

Table A3. *Cont.*

	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}	x_{11}	x_{12}	x_{13}	x_{14}	x_{15}	x_{16}	x_{17}	x_{18}	x_{19}	x_{20}	x_{21}	D
x_{19}	0.4121	0.3761	0.4080	0.2953	0.4152	0.4184	0.3502	0.3494	0.4241	0.3487	0.4369	0.4355	0.4005	0.3768	0.3864	0.3927	0.4003	0.3678	0.3325	0.3908	0.4043	8.1222
x_{20}	0.4204	0.3838	0.4061	0.2953	0.4229	0.4195	0.3554	0.3573	0.4256	0.3565	0.4430	0.4436	0.4128	0.3883	0.3923	0.3999	0.4035	0.3790	0.3885	0.3440	0.4067	8.2444
x_{21}	0.4185	0.3811	0.4041	0.2923	0.4147	0.4209	0.3543	0.3535	0.4301	0.3528	0.4467	0.4446	0.4114	0.3822	0.3923	0.3992	0.4092	0.3757	0.3855	0.3897	0.3571	8.2159
R	8.4765	7.7433	7.9568	5.8084	8.2112	8.2565	7.2051	7.2024	8.4045	7.1883	8.8452	8.8662	8.1217	7.7933	7.9467	8.0698	8.1125	7.5316	7.5444	7.7037	8.0196	

Table A4. Limiting Super Matrices ($\rho = 0.5$).

	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}	x_{11}	x_{12}	x_{13}	x_{14}	x_{15}	x_{16}	x_{17}	x_{18}	x_{19}	x_{20}	x_{21}
x_1	0.0487	0.0487	0.0487	0.0487	0.0487	0.0487	0.0487	0.0487	0.0487	0.0487	0.0487	0.0487	0.0487	0.0487	0.0487	0.0487	0.0487	0.0487	0.0487	0.0487	0.0487
x_2	0.0491	0.0491	0.0491	0.0491	0.0491	0.0491	0.0491	0.0491	0.0491	0.0491	0.0491	0.0491	0.0491	0.0491	0.0491	0.0491	0.0491	0.0491	0.0491	0.0491	0.0491
x_3	0.0485	0.0485	0.0485	0.0485	0.0485	0.0485	0.0485	0.0485	0.0485	0.0485	0.0485	0.0485	0.0485	0.0485	0.0485	0.0485	0.0485	0.0485	0.0485	0.0485	0.0485
x_4	0.0365	0.0365	0.0365	0.0365	0.0365	0.0365	0.0365	0.0365	0.0365	0.0365	0.0365	0.0365	0.0365	0.0365	0.0365	0.0365	0.0365	0.0365	0.0365	0.0365	0.0365
x_5	0.0501	0.0501	0.0501	0.0501	0.0501	0.0501	0.0501	0.0501	0.0501	0.0501	0.0501	0.0501	0.0501	0.0501	0.0501	0.0501	0.0501	0.0501	0.0501	0.0501	0.0501
x_6	0.0462	0.0462	0.0462	0.0462	0.0462	0.0462	0.0462	0.0462	0.0462	0.0462	0.0462	0.0462	0.0462	0.0462	0.0462	0.0462	0.0462	0.0462	0.0462	0.0462	0.0462
x_7	0.0436	0.0436	0.0436	0.0436	0.0436	0.0436	0.0436	0.0436	0.0436	0.0436	0.0436	0.0436	0.0436	0.0436	0.0436	0.0436	0.0436	0.0436	0.0436	0.0436	0.0436
x_8	0.0459	0.0459	0.0459	0.0459	0.0459	0.0459	0.0459	0.0459	0.0459	0.0459	0.0459	0.0459	0.0459	0.0459	0.0459	0.0459	0.0459	0.0459	0.0459	0.0459	0.0459
x_9	0.0468	0.0468	0.0468	0.0468	0.0468	0.0468	0.0468	0.0468	0.0468	0.0468	0.0468	0.0468	0.0468	0.0468	0.0468	0.0468	0.0468	0.0468	0.0468	0.0468	0.0468
x_{10}	0.0458	0.0458	0.0458	0.0458	0.0458	0.0458	0.0458	0.0458	0.0458	0.0458	0.0458	0.0458	0.0458	0.0458	0.0458	0.0458	0.0458	0.0458	0.0458	0.0458	0.0458
x_{11}	0.0475	0.0475	0.0475	0.0475	0.0475	0.0475	0.0475	0.0475	0.0475	0.0475	0.0475	0.0475	0.0475	0.0475	0.0475	0.0475	0.0475	0.0475	0.0475	0.0475	0.0475
x_{12}	0.0483	0.0483	0.0483	0.0483	0.0483	0.0483	0.0483	0.0483	0.0483	0.0483	0.0483	0.0483	0.0483	0.0483	0.0483	0.0483	0.0483	0.0483	0.0483	0.0483	0.0483
x_{13}	0.0508	0.0508	0.0508	0.0508	0.0508	0.0508	0.0508	0.0508	0.0508	0.0508	0.0508	0.0508	0.0508	0.0508	0.0508	0.0508	0.0508	0.0508	0.0508	0.0508	0.0508
x_{14}	0.0480	0.0480	0.0480	0.0480	0.0480	0.0480	0.0480	0.0480	0.0480	0.0480	0.0480	0.0480	0.0480	0.0480	0.0480	0.0480	0.0480	0.0480	0.0480	0.0480	0.0480
x_{15}	0.0494	0.0494	0.0494	0.0494	0.0494	0.0494	0.0494	0.0494	0.0494	0.0494	0.0494	0.0494	0.0494	0.0494	0.0494	0.0494	0.0494	0.0494	0.0494	0.0494	0.0494
x_{16}	0.0486	0.0486	0.0486	0.0486	0.0486	0.0486	0.0486	0.0486	0.0486	0.0486	0.0486	0.0486	0.0486	0.0486	0.0486	0.0486	0.0486	0.0486	0.0486	0.0486	0.0486
x_{17}	0.0494	0.0494	0.0494	0.0494	0.0494	0.0494	0.0494	0.0494	0.0494	0.0494	0.0494	0.0494	0.0494	0.0494	0.0494	0.0494	0.0494	0.0494	0.0494	0.0494	0.0494
x_{18}	0.0478	0.0478	0.0478	0.0478	0.0478	0.0478	0.0478	0.0478	0.0478	0.0478	0.0478	0.0478	0.0478	0.0478	0.0478	0.0478	0.0478	0.0478	0.0478	0.0478	0.0478
x_{19}	0.0492	0.0492	0.0492	0.0492	0.0492	0.0492	0.0492	0.0492	0.0492	0.0492	0.0492	0.0492	0.0492	0.0492	0.0492	0.0492	0.0492	0.0492	0.0492	0.0492	0.0492
x_{20}	0.0499	0.0499	0.0499	0.0499	0.0499	0.0499	0.0499	0.0499	0.0499	0.0499	0.0499	0.0499	0.0499	0.0499	0.0499	0.0499	0.0499	0.0499	0.0499	0.0499	0.0499
x_{21}	0.0498	0.0498	0.0498	0.0498	0.0498	0.0498	0.0498	0.0498	0.0498	0.0498	0.0498	0.0498	0.0498	0.0498	0.0498	0.0498	0.0498	0.0498	0.0498	0.0498	0.0498

Table A5. Overall and intra-system rankings for factors.

	D	R	$D+R$	$D-R$	DEMTAL	DANP	Borda	Overall Ranking	Intra-System Ranking
x_1	8.0347	8.4765	16.5112	−0.4418	3	9	12	5	2
x_2	8.1027	7.7433	15.8461	0.3594	14	8	22	11	5
x_3	8.0070	7.9568	15.9638	0.0502	11	11	22	11	5
x_4	6.0175	5.8084	11.8259	0.2090	21	21	42	21	12
x_5	8.2728	8.2112	16.4840	0.0617	5	2	7	2	1
x_6	7.6148	8.2565	15.8713	−0.6418	13	17	30	16	8
x_7	7.1948	7.2051	14.3999	−0.0103	20	20	40	20	11
x_8	7.5692	7.2024	14.7717	0.3668	18	18	36	18	9
x_9	7.7156	8.4045	16.1201	−0.6889	8	16	24	14	7
x_{10}	7.5601	7.1883	14.7483	0.3718	19	19	38	19	10
x_{11}	7.8400	8.8452	16.6852	−1.0053	2	15	17	9	4
x_{12}	7.9592	8.8662	16.8254	−0.9069	1	12	13	6	3
x_{13}	8.3847	8.1217	16.5064	0.2630	4	1	5	1	1
x_{14}	7.9226	7.7933	15.7159	0.1293	15	13	28	15	8
x_{15}	8.1471	7.9467	16.0938	0.2003	10	6	16	8	5
x_{16}	8.0281	8.0698	16.0978	−0.0417	9	10	19	10	6
x_{17}	8.1610	8.1125	16.2735	0.0485	6	5	11	3	2
x_{18}	7.8935	7.5316	15.4251	0.3618	17	14	31	17	9
x_{19}	8.1222	7.5444	15.6666	0.5778	16	7	23	13	7
x_{20}	8.2444	7.7037	15.9481	0.5407	12	3	15	7	4
x_{21}	8.2159	8.0196	16.2355	0.1963	7	4	11	3	2

Table A6. The results of coupling coordination model.

	C	T	CCD
2005	0.4912	0.2342	0.3391
2006	0.4920	0.2428	0.3456
2007	0.4930	0.2568	0.3558
2008	0.4915	0.2678	0.3628
2009	0.4916	0.2750	0.3677
2010	0.4937	0.3000	0.3848
2011	0.4954	0.3240	0.4006
2012	0.4955	0.3425	0.4120
2013	0.4968	0.3655	0.4261
2014	0.4976	0.3802	0.4349
2015	0.4972	0.4003	0.4461
2016	0.4977	0.4228	0.4587
2017	0.4981	0.4452	0.4709
2018	0.4972	0.4589	0.4776
2019	0.4968	0.4738	0.4851

References

1. Nguyen, T.T.; Nguyen, V.C. Financial Development and Renewables in Southeast Asian Countries—The Role of Organic Waste Materials. *Sustainability* **2021**, *13*, 8748. [CrossRef]
2. Li, L. China's manufacturing locus in 2025: With a comparison of "Made-in-China 2025" and "Industry 4.0". *Technol. Forecast. Soc. Chang.* **2018**, *135*, 66–74. [CrossRef]
3. Zhironkin, S.; Cehlár, M. Green Economy and Sustainable Development: The Outlook. *Energies* **2022**, *15*, 1167. [CrossRef]
4. Benhabib, J.; Spiegel, M.M. The role of human capital in economic development evidence from aggregate cross-country data. *J. Monet. Econ.* **1994**, *34*, 143–173. [CrossRef]
5. Bu, N.; Li, Y.; Kong, H. Research on the impact path of regional tourism economic development based on fsqca method—A case study of 17 cities in Shandong Province. *Dongyue Trib.* **2020**, *41*, 180–190.
6. Lepak, D.P.; Snell, S.A. The human resource architecture: Toward a theory of human capital allocation and development. *Acad. Manag. Rev.* **1999**, *24*, 31–48. [CrossRef]
7. Chengliang, Z.; Ping, S.; Hongzhi, Y.; Xianfeng, H. Human Capital, Human Capital Structure and Regional Economic Growth Efficiency. *China Soft Sci.* **2011**, *2*, 110–119.

8. Sghaier, I.M. Foreign capital inflows and economic growth in north African countries: The role of human capital. *J. Knowl. Econ.* **2021**, *147*, 1–18.
9. Ali, M.; Egbetokun, A.; Memon, M.H. Human capital, social capabilities and economic growth. *Economies* **2018**, *6*, 2. [CrossRef]
10. Deng, J.R.; Long, R.R. A study of the impact of idiosyncratic human capital on China's regional economic growth. *Sci. Res. Manag.* **2017**, *38*, 116–121.
11. Liu, M.; Li, Y.; Pérez-Sánchez, M.d.l.Á.; Luo, J.; Bu, N.; Chen, Y.; Bao, J. Empirical Study on the Sustainable Development of Mountain Tourism in the Early Stage of High-Speed Railways—Taking the Southwest Mountainous Region of China as an Example. *Sustainability* **2022**, *14*, 1058. [CrossRef]
12. Vinod, H.D.; Kaushik, S.K. Human capital and economic growth: Evidence from development countries. *Am. Econ.* **2007**, *51*, 29–39. [CrossRef]
13. Zhang, Y. Human capital contribution and the sustainability of Chinese economic growth. *World Econ.* **2020**, *43*, 75–99.
14. Filmer, D.; Pritchett, L. The effect of household wealth on educational attainment: Evidence from 35 countries. *Popul. Dev. Rev.* **1999**, *25*, 85–120. [CrossRef]
15. Ma, L. Research on the impact of demographic structure transformation on economic growth. *Stat. Decis.* **2021**, *7*, 118–122.
16. Ji, X.; Wang, S.; Xiao, H.; Bu, N.; Lin, X. Contagion Effect of Financial Markets in Crisis: An Analysis Based on the DCC–MGARCH Model. *Mathematics* **2022**, *10*, 1819. [CrossRef]
17. Wang, W.Y.; Li, W.B.; Zheng, J.Q. Economic servitization, human capital accumulation and high-quality growth. *Southeast Acad.* **2021**, *2*, 124–134.
18. Zhihua, D. Research on the Interaction between Human Capital and Economic Growth: An Empirical Analysis Based on China's Human Capital Index. *Macroecon. Res.* **2017**, *4*, 88–98.
19. Zhen, L.; Jianjie, G.; Tiqin, Z. Research on the relationship between healthy human capital investment and regional economy based on grey relational analysis: Taking Shandong Province as an example. *Rev. Econ. Manag.* **2016**, *32*, 129–136.
20. Le, R. Correlation Analysis of Heterogeneous Human Capital on Regional Economic Coupling—Based on Data Test of 18 Cities in Henan Provinc. *Econ. Manag.* **2014**, *36*, 31–38.
21. Jin, L.; Huimin, Z. An Empirical Analysis of the Coupling Relationship between Human Capital and Economic Growth in China's Provinces. *Res. Quant. Econ. Tech. Econ.* **2013**, *30*, 3–19.
22. Di, Z.; Maoxiang, Z. Differences and coupling paths between human capital and economic growth in five major urban agglomerations. *Stat. Decis. Mak.* **2020**, *36*, 67–71.
23. Chen, K.; Zhang, X.L. High-quality coordinated development of real economy and human resources: Mechanism, performance and path. *Economics* **2021**, *1*, 79–89.
24. Patrick, C.; Stephens, H. Incentivizing the missing middle: The role of economic development policy. *Econ. Dev. Q.* **2020**, *34*, 154–170. [CrossRef]
25. Fleisher, B.; Li, H.; Min, Q.Z. Human capital, economic growth, and regional inequality in China. *Soc. Sci. Electron. Publ.* **2009**, *92*, 215–231.
26. Hanushek, E.A. Economic growth in developing countries: The role of human capital. *China Econ. Educ. Rev.* **2013**, *37*, 204–212. [CrossRef]
27. Sabadie, J.A. Technological innovation, human capital and social change for sustainability. Lessons learnt from the Industrial Technologies Theme of the EU's Research Framework Programme. *Sci. Total Environ.* **2014**, *481*, 668–673. [CrossRef]
28. Costantini, V.; Monni, S. Environment, human development and economic growth. *Ecol. Econ.* **2006**, *64*, 867–880. [CrossRef]
29. Tong, H.F.; Wang, Y.; Xu, J.J. Green transformation in China: Structures of endowment, investment, and employment. *Struct. Chang. Econ. Dyn.* **2020**, *54*, 173–185. [CrossRef]
30. Castello-Climent, A.; Hidalgo-Cabrillana, A. The Role of Educational Quality and Quantity in the Process of Economic Development. *Econ. Educ. Rev.* **2012**, *31*, 391–409. [CrossRef]
31. Ahmed, E.M. Are the FDI inflow spillover effects on Malaysia's economic growth input driven? *Econ. Model.* **2012**, *4*, 1498–1504. [CrossRef]
32. Hye Qazi, M.A. Long term effect of trade openness on economic growth in case of Pakistan. *Qual. Quant.* **2012**, *4*, 1137–1149.
33. Pelinescu, E.; Pauna, C.; Saman, C.; Diaconescu, T. Human capital, innovation and economic growth in the EU countries. *Rom. J. Econ. Forecast.* **2020**, *4*, 160–173.
34. Jiang, P.; Hu, Y.C.; Yen, G.F. Applying grey relathional analysis to find interactions between manufacturing and logistics industries in Taiwan. *Adv. Manag. Appl. Econ.* **2017**, *7*, 21–40.
35. Mubarik, M.S.; Kazmi, S.H.A.; Zaman, S.I. Application of gray DEMATEL-ANP in green-strategic sourcing. *Technol. Soc.* **2021**, *64*, 101524. [CrossRef]
36. Kumar, A.; Anbanandam, R. Analyzing interrelationships and prioritising the factors influencing sustainable intermodal freight transport system: A grey-DANP approach. *J. Clean. Prod.* **2020**, *252*, 119769. [CrossRef]
37. Liu, C.; Li, K.; Jiang, P.; Li, D.; Su, L.; Li, A. A hybrid multiple criteria decision-making technique to evaluate regional intellectual capital: Evidence from China. *Mathematics* **2021**, *9*, 1676. [CrossRef]
38. Du, X.; Fang, C.L.; Ma, H. Coupling Coordination and Space-Time Evolution of Tourism Economy and Urbanization in Coastal Provinces: Taking Shandong Province as an Example. *Econ. Surv.* **2021**, *38*, 15–26.

39. Jiang, Y.; Ma, Y.F.; Gao, N.; Wang, Y.M. Research on the Coupling Coordination Degree of Regional Tourism Industry and Economy—Taking Ten Eastern Provinces (Cities) as Examples. *East China Econ. Manag.* **2012**, *26*, 47–50.
40. Li, L.; Hong, X.F.; Wang, J.; Xie, X.L. Research on the Coupling and Coordinated Development of Economy-Energy-Environment System Based on PLS and ESDA. *Soft Sci.* **2018**, *32*, 44–48.
41. Duan, P.L.; Liu, S.G.; Yin, P.; Zhang, H.F. Coordination of Space-Time Coupling Coordination between Development Intensity and Resources and Environment Carrying Capacity of China's Coastal Cities. *Econ. Geogr.* **2018**, *38*, 60–67.
42. Yang, S.X.; Xu, J.F.; Yang, R.Y. Research on Coordination and Driving Factors of Sports Industry and Regional Sustainable Development-Empirical Research Based on Panel Data of Provinces and Cities in Eastern China. *Sustainability* **2020**, *12*, 813. [CrossRef]
43. Shandong Statistical Yearbook. Available online: https://data.cnki.net/Yearbook/Navi?type=type&code=A (accessed on 20 April 2021).