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Construction of an economic quality index assessment model based on quantitative analysis methods

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Abstract This paper constructs the evaluation index system of economic quality development from six dimensions, including economic fundamentals and ecological environment. In order to scientifically assess the level of economic quality development of each province and ensure the rationality of the assignment method and the availability of data, this paper selects 31 provinces in China as the research object, combines the hierarchical analysis method (AHP) and entropy weighting method (EWM) to assign weights to the indexes and combines with the TOPSIS method to make a comprehensive assessment of the level of economic quality development of each province. The results show that the comprehensive realization level of China's economic quality development in China is low, the spatial differences are obvious, and the contradiction of unbalanced regional economic development is very prominent. Overall, the spatial distribution pattern of "strong in the east and weak in the west, high in the south and low in the north, with east China as the leader, north and south-central China as the two wings, southwestern and northeastern China as the center, and northwestern China as the bottom" is shown. From the provincial perspective, Beijing, Shanghai and Guangdong have a high level of economic quality development, while nine provinces, including Gansu, Qinghai and Xinjiang, have a low level of economic quality development. The analysis of the influencing factors of China's economic quality development learns that GDP and government intervention play an important role in economic quality development.

Index Terms Entropy weight method, Hierarchical analysis method, TOPSIS method economic development, assessment modeling

I. Introduction

Since the reform and opening up, China's economy has experienced 30 years of rapid growth, with an average annual GDP growth rate of 9.8%, becoming the world's second-largest economy after the United States, and Nobel Prize-winning economist Stiglitz believes that the world has not seen such large-scale and long-lasting economic growth [1], [2]. However, it is an indisputable fact that China is big but not strong, and the quality of growth is not high. As China's economic development moves from the pre-reform era to the post-reform era, the quality of economic growth has become a key factor in determining economic development [3]. In recent years, due to the prominence of the quality of economic growth, the research on the quality of economic growth has attracted a lot of attention, and the theme of the 2011 Summer Davos Conference in Dalian was set as "Focusing on the Quality of Growth, Controlling the Economic Pattern" [4], [5]. At the same time, research on the quality of China's economy is also endless, and the basic judgment on the quality of China's economic growth is also a hot topic of discussion.

For the research on economic quality index, the most representative results are the economic quality index compiled by the U.S. Information Technology and Innovation Foundation since 1999, which believes that the economy is a networked, globalized, high-risk, dynamic knowledge-based economy, from which it has constructed five indicators reflecting the assessment of economic quality, and so far released eight reports on "U.S. Economic Quality Index" [6]-[8]. Literature [9] constructed an EQI assessment model based on key macroeconomic indicators and found that Lithuania's development was hampered by a decline in employment and a decline in foreign direct investment, while the EU and the Eurozone also experienced a decline in their EQIs during this period. Literature [10] used the entropy method combined with the hierarchical analysis method to build a model for evaluating the quality of economic development, which was used to measure the state of economic development in China and the provinces. Literature [11] developed a modeling toolkit for assessing the relationship between economic sentiment and confidence calculation indices, investigated the relationship between the economic sentiment index and GDP dynamics, and found that the sentiment index has predictive power for GDP growth. Literature [12] proposed a data-driven approach using genetic programming to construct survey-based economic indicators, which outperforms a benchmark model in tracking GDP. Literature [13] used a fuzzy qualitative comparative analysis (fsQCA) methodology to assess the quality of the economy in terms of indicators such as Logistics Performance Index (LPI), Ease of Doing Business (EODB), and Logistics Costs (LC) on economic development (GDP per capita). Literature [14] constructed a system of indicators containing 26 factors based on economic, social and environmental aspects and developed a composite index to measure the performance of green economy, which can be used to assess a country's green economy. Literature [15] proposed a new Sustainable Economy Index (SEI) which combines economic, environmental and social indicators to assess the sustainability of economic development. Literature [16] proposed a methodology based on a linear programming model that considers factors such as resource utilization, income and profit, and utilizes the Malmquist Index and the Malmquist Global Index to evaluate changes in the economic productivity of a decision-making unit.

In this paper, 19 representative indicators reflecting the need for economic quality development in each province are selected from six dimensions: economic fundamentals, ecological environment, education level, employment quality, medical level, and urban construction, and the evaluation index system of economic quality development is constructed. After that, the hierarchical analysis method (AHP) was combined with the entropy weight method (EWM) to form the subjective-objective combination empowerment evaluation method (AHP-EWM) to empower the indicators. On this basis, the level measurement indicators of economic quality development of 31 provinces in China in 2024 were empirically analyzed using the TOPSIS method.

II. Economic quality assessment model based on quantitative analysis

II. A. Construction of evaluation index system

II. A. 1) Principles for setting the indicator system

(1) Comprehensiveness of coverage. The development of economic quality is not the rapid progress of a certain aspect of the economy and society, and the construction of the evaluation index system must also focus on this, and needs to comprehensively and widely reflect the current stage of the general people's aspirations for a better life.

(2) Representativeness of evaluation dimensions. The selection of evaluation indicators should take into account both comprehensiveness and typicality and representativeness, selecting several dimensions that best represent the people's aspirations for a better life, and selecting 1~3 indicators in each dimension that can fully reflect the characteristics of the dimension as the measurement standard.

(3) Availability of indicator data. When selecting indicators, the availability of data should be fully considered, and the evaluation indicators should be set up scientifically with reference to the statistical yearbooks and other official information of each region.

II. A. 2) Content of the indicator system

This paper measures the level of economic quality development from seven dimensions closely related to the good life, such as economic fundamentals, ecological environment, education level, etc. The system of economic quality development evaluation indexes and their weights are shown in Table 1.

(1) Economic fundamentals. Economic fundamentals measure the quality of local economic growth, and this paper draws on existing literature to measure the three dimensions of economic growth: intensity, stability, and rationality of industrial structure.

The intensity of economic growth is measured by GDP per capita; a higher GDP per capita indicates a greater potential for economic development in the region.

The stability of economic growth is related to the fairness of the social environment, the more stable the economic development of the region, the fairer the social environment. Stability can be measured by the coefficient of variation of the GDP growth rate, and a higher coefficient of variation indicates a more unstable economic development. In order to smooth the impact of short-term fluctuations on macroeconomic variables, the measurement of the coefficient of variation of GDP growth rate in this paper uses 1-year rolling window data.

The rationality of industrial structure is generally measured by the Tel index (TL) [17]. According to the assumption of classical economics, when the economy reaches equilibrium, that is, when the allocation of factors among industries reaches Pareto optimality, the marginal productivity of factors in each industrial sector is equal, and at this time, there is $Y_i/L_i = Y/L$, i.e., TL = 0, so the smaller the TL is, the more reasonable the industrial structure is indicated.

(2) Ecological environment. This paper mainly selects indicators from three aspects of air quality, water pollution and solid waste disposal which are directly related to people's life. The number of good air quality days (the percentage of days with air quality better than Grade 2 or above for the whole year) is used to measure the local air

quality, and the unit wastewater emissions and the comprehensive utilization rate of general solid waste are used to measure the green development of the economy.

(3) Education level. The penetration rate of higher education is measured by the number of college students per 10,000 people enrolled in schools. The quality of education should be measured by the student-teacher ratio of students enrolled in general higher education institutions and the academic level of full-time teachers in general higher education institutions, but given the difficulty in obtaining data on the academic level of teachers, only the student-teacher ratio of students enrolled in general higher education institutions was selected as an indicator.

(4) Employment quality. The quality of employment under quality development not only focuses on the level of income, but also takes into account the unemployment rate and the rate of employee participation in insurance. The urban registered unemployment rate is used to measure the unemployment rate, the ratio of insured employees (the ratio of the minimum number of insured persons to the number of employed persons in employee medical insurance, employee pension insurance, unemployment insurance, work injury insurance and maternity insurance) is used to measure employment security, and the average wage of on-the-job employees is used to measure the income level.

(5) Level of medical care. The number of practicing physicians per 10,000 people is used to measure the probability of facing a high-level doctor when seeking medical care, and the number of hospital beds per 10,000 people is used to measure the likelihood of waiting for a bed when being hospitalized.

(6) Urbanization. The convenience of travel is measured by the ratio of mileage of graded highways, the greening of the city is measured by the green area of parks per capita, and the level of informatization is measured by the number of households with Internet user access divided by the total number of households.

The Thiel index is calculated by the formula:

$$TL = \sum_{i=1}^{n} (Y_i / Y) \ln\left[(Y_i / L_i) / (Y / L)\right] \tag{1}$$

Table 1: Economic high quality development evaluation index system

Dimension	Mean weight	Specific indicators and code	Index abbreviation	Mean weight	Entropy weighting
A:Economic fundamentals	1/7	Per capita GDP	A1	1/3	0.1048
		GDP growth rate variation coefficient	A2	1/3	0.0472
		Industry tyre index	A3	1/3	0.0528
B:Ecological environment	1/7	Unit effluent discharge	B1	1/3	0.0582
		Good air quality days	B2	1/3	0.0624
		General solid waste utilization	B3	1/3	0.0331
C:Education level	1/7	The number of college students per 10,000 people	C1	1/3	0.0376
		The general higher school is in the school student ratio	C2	1/3	0.0385
D:Quality of employment	1/7	Urban registration unemployment	D1	1/3	0.0117
		The proportion of the staff member	D2	1/3	0.0981
		The average salary of the workers in the field	D3	1/3	0.1302
E:Medical level	1/7	Number of occupational physicians per 10,000 people	E1	1/3	0.0603
		Sleeping beds for every 10,000 hospital	E2	1/3	0.0967
F:Urban construction	1/7	Grade road mileage ratio	F1	1/3	0.0546
		Per capita park	F2	1/3	0.0539
		Internet access to users	F3	1/3	0.0169
G:Urban and rural collaborative development	1/7	Urban and rural residents income	G1	1/3	0.0146
		Urban dwellers' Engels' coefficient	G2	1/3	0.0121
		Rural Engels coefficient	G3	1/3	0.0163

When calculating the Industry Tel Index, Y represents the local GDP, L represents the number of employees; Y_i represents the value added of the i th industry, L_i represents the number of employees of the i th industry; $i=1$ represents the primary industry, $i=2$ represents the secondary industry, $i=3$ represents the tertiary industry, $n=3$. When calculating the Terrell Index of Urban and Rural Residents' Income, Y denotes the disposable income of local residents, L denotes the local resident population; Y_1 denotes the disposable income of urban residents, Y_2 denotes the disposable income of rural residents; L_1 denotes the resident population of towns, L_2 denotes the resident population in rural areas; $n=2$.

II. B.Empowerment of indicators of quality development of the urban economy

II. B. 1) Determination of indicator weights and subjective-objective combination of evaluation methods

(1) Subjective Weighting - Improved Hierarchical Analysis Method (AHP)

Establish the structural model of hierarchical analysis method [18]. Divide the model into target layer, criterion layer and indicator layer. The target layer is the comprehensive evaluation of the economic quality of 31 provinces, the criterion layer is the construction level of each province, the logistics service level, the economic environment of each province, the throughput of each province and the development potential of each province, and the indicator layer is the 19 specific indicators under the criterion layer.

Constructing judgment matrix. In this paper, we adopt a 9-level scaling method to compare each indicator within the same level two by two to determine their importance relative to the factors in the previous level, and finally form a judgment matrix $A=\left(a_{ij}\right)n*n$, which is used for the subsequent computation of weights.

Hierarchical single sort weights and consistency test. Calculate the weight vector W of each indicator based on the judgment matrix A, and then conduct consistency test on the judgment matrix to ensure the logical consistency of the judgment and the reasonableness of the calculation results.

(2) Calculate the hierarchical single sorting weights:

a) Normalized judgment matrix: normalize each column of the judgment matrix A and calculate the normalized matrix B:

$$B_{ij}=\frac{A_{ij}}{\sum_{j=1}^{n}A_{ij}},\quad i,j=1,2,\cdots,n \tag{2}$$

b) Calculate the weight vector: find the average of each row of the normalized matrix, i.e., the weight vector of the hierarchical single ordering W:

$$W_i=\frac{\sum_{j=1}^{n}B_{ij}}{n},\quad i=1,2,\cdots,n \tag{3}$$

where W_i is the relative weight of each indicator that satisfies the normalization constraint $\sum W_i=1$.

Consistency test:

a) Calculate the maximum eigenvalue $\lambda_{\max}$:

$$\lambda_{\max}=\sum_{i=1}^{n}\frac{\left(AW\right)_i}{w_i} \tag{4}$$

where $\left(AW\right)_i$ is the result of multiplying the judgment matrix A by the weight vector W.

b) Calculate the consistency index (CI):

$$CI=\frac{\lambda_{\max}-n}{n-1} \tag{5}$$

where n is the order of the judgment matrix. When CI is closer to 0, it means that the consistency of the judgment matrix is better.

c) Calculate the consistency ratio (CR):

$$CR=\frac{CI}{RI} \tag{6}$$

If $CR<0.10$, the judgment matrix passes the consistency test; if $CR\geq 0.10$, the judgment matrix needs to be adjusted until the consistency requirement is met.

II. B. 2) Objective weight assignment method - entropy weight method

Entropy weight method (EWM) [19] is an objective assignment method based on the statistical characteristics of the data, which measures the amount of information of the indicators through the information entropy and then determines their importance.

(1) Due to the different magnitudes of the indicators, in order to ensure the fairness of the weight calculation, it is first necessary to standardize the raw data. The standardization method is as follows:

Positive indicators (the larger the value, the better):

$$x_{ij}^{*}=\frac{x_{ij}-x_{\min j}}{x_{\max j}-x_{\min j}} \tag{7}$$

Negative indicators (smaller values are better):

$$x_{ij}^{*}=\frac{x_{\max j}-x_{ij}}{x_{\max j}-x_{\min j}} \tag{8}$$

where x_{ij} is the raw data of the i th city of each province on the j th indicator, and $x\max j$ and $x\min j$ are the maximum and minimum values of the j th indicator, respectively.

(2) Calculate the entropy value

For the standardized data, calculate the information entropy of each indicator, and the entropy value is calculated as follows:

$$E_{j}=-k\sum_{i=1}^{m}P_{ij}\ln P_{ij},k=\frac{1}{\ln m} \tag{9}$$

Among them, P_{ij} is the information proportion of i provinces and cities on the j index, k is the normalized coefficient, and the value range of the entropy value is $[0,1]$, E_j reflects the information entropy of the j index, if E_j is larger, it means that the information distribution of the index is more uniform and has less impact on decision-making.

(3) Calculate the entropy weight value (weight distribution)

Calculate the objective weight of each indicator according to the entropy value, the formula is as follows:

$$W_{j'}=\frac{1-E_{j}}{\sum_{j=1}^{n}\left(1-E_{j}\right)} \tag{10}$$

where W_j denotes the weight of the j th indicator, and $1-E_j$ reflects the extent to which the indicator contributes to the overall evaluation.

II. B. 3) Subjective and objective combination empowerment evaluation method (AHP-EWM)

Combining the hierarchical analysis method (AHP) with the entropy weight method (EWM) [20], [21], the formula is as follows:

$$W_{\mathrm{j}}^{f}=\alpha W_{\mathrm{j}}^{'}+(1+\alpha)W_{\mathrm{j}}^{*} \tag{11}$$

where: W_{j}^{f} is the final indicator weight after combination assignment; $W_{\mathrm{j}}^{'}$ is the calculated subjective weight; W_{j}^{*} is the calculated objective weight; α is the weight adjustment coefficient, and the final weight calculation results.

II. C. Constructing a model for measuring the level of quality development of the economy

(1) Construction of a weighting matrix of indicators for measuring the level of quality development of the economy R :

$$R=(r_{ij})_{n\times m} \tag{12}$$

where $i=1,\cdots,n$; $j=1,\cdots,m$; $n=11$; $m=11$. $r_{ij}=w_{j}\times y_{ij}$.

(2) Determine the optimal solution Q_j^+ and the worst solution Q_j^- based on the weighting matrix R :

$$Q_j^+ = \left(\max r_{i1}, \max r_{i2}, \cdots, \max r_{im}\right) \tag{13}$$

$$Q_j^- = \left(\min r_{i1}, \min r_{i2}, \cdots, \min r_{im}\right) \tag{14}$$

where $i = 1, \cdots, n$; $j = 1, \cdots, m$; $n = 11$; $m = 11$.

(3) Calculate the distance D_j^+ and D_j^- between each measurement scheme and the optimal scheme Q_j^+ and the worst scheme Q_j^- :

$$D_j^+ = \sqrt{\sum_{j=1}^{m} \left(Q_j^+ - r_{ij}\right)^2} \tag{15}$$

$$D_j^- = \sqrt{\sum_{j=1}^{m} \left(Q_j^- - r_{ij}\right)^2} \tag{16}$$

where, $i = 1, \cdots, n$; $j = 1, \cdots, m$; $n = 11$; $m = 11$.

(4) Calculate the relative proximity of each measurement scheme to the ideal scheme C_i :

$$C_i = \frac{D_j^-}{D_j^+ + D_j^-} \tag{17}$$

where, $i = 1, \cdots, n$; $j = 1, \cdots, m$; $n = 11$; $m = 11$. $0 < C_i < 1$, C_i represents the composite score, the closer to 1, the higher the level of economic quality development.

III. Analysis of the results of the empirical measurement of the level of quality-based development

III. A. Empirical measurement of China's inter-provincial economic quality development level

III. A. 1) Sample Selection and Data Organization

In this paper, 31 provinces (municipalities and autonomous regions) in China were taken as the research objects. In terms of data sources: data such as technology market turnover, new product sales revenue, R&D expenditure, and number of R&D personnel are from the 2024 China Science and Technology Statistical Yearbook; The total import and export trade of high-tech industries and the sales revenue of new products in high-tech industries are from the 2024 China High-tech Industry Statistical Yearbook; The data on foreign trade investment in fixed assets and international tourism revenue are from the 2024 China Trade and Foreign Economic Statistical Yearbook; Pesticide use and other data are from the 2024 China Rural Statistical Yearbook; The business environment index comes from the "2024 China Provincial Administrative Region Business Environment Index Evaluation Report" by Wanbo New Economic Research Institute; The data used in the calculation of the other measurement indicators are from the 2024 China Statistical Yearbook and the statistical yearbooks of various provinces (municipalities and autonomous regions).

III. A. 2) Empirical measurement and analysis of results

Based on the economic quality development measurement system constructed in the previous section, the results of measuring the economic quality development level of Chinese provinces in 2024 can be obtained as shown in Figure 1.

The scores of the 31 provinces on the comprehensive level of economic quality development are shown in Figure 2. The scores of the 31 provinces on the comprehensive level of economic quality development range from 0.0715 to 0.815, with the highest score in Beijing and the lowest score in Gansu, and the gap between provinces is very large. On the whole, the mean value of the score of each province is 0.34457, and the standard deviation is 0.1431, indicating that the comprehensive realization level of China's economic quality development is low, the spatial difference is obvious, and the contradiction of unbalanced regional economic development is very prominent.

In order to better reveal the spatial differences and distribution pattern of China's economic quality development, all provinces are categorized into advanced, general and backward types. The advanced type includes seven provinces: Beijing, Shanghai, Guangdong, Zhejiang, Jiangsu, Tianjin and Fujian; the average type includes 15 provinces: Shaanxi, Hubei, Hainan, Liaoning, Jiangxi, Chongqing, Guangxi, Anhui, Sichuan, Yunnan, Hunan, Guizhou, Shandong, Jilin and Tibet; and the backward type includes nine provinces: Heilongjiang, Henan, Inner Mongolia, Hebei, Shanxi, Ningxia, Xinjiang, Qinghai and Gansu.

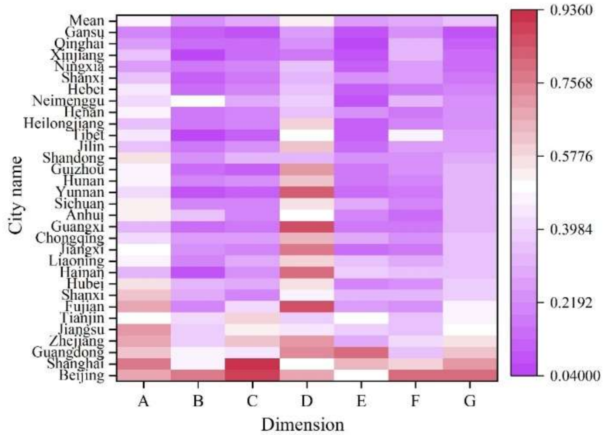

Figure 1: The results of the high quality of the provinces are measured

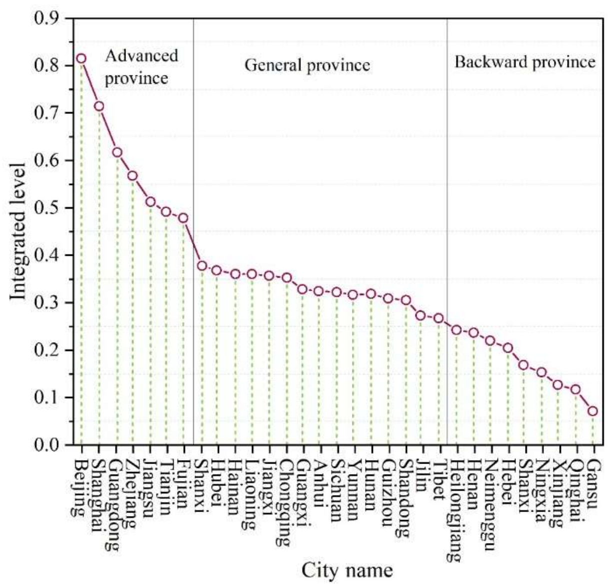

Figure 2: Overall level of economic development of the provinces

From the perspective of regional economic development, it is not unexpected that all the advanced provinces are located in the eastern region; however, the fact that all the backward provinces are located in the north (Northwest, North China, Northeast) reveals that the imbalance in economic development between China's north and south is becoming increasingly prominent, and that it should be given sufficient attention. In order to further analyze the regional analysis, the next three perspectives are from the north-south vertical, east-west horizontal, and the six regions of North China, East China, Central and South China, Southwest China, Northwest China, and Northeast China, and the results of measuring the level of economic quality and development of China's major regions are shown in Table 2.

Analyzed from the perspective of the country's six regions, the scores are, in descending order: East China, North China, Central and South China, Southwest China, Northeast China, and Northwest China. Among them, among the seven provinces in East China, there are four advanced and three average-type provinces; among the five provinces in North China, there are two advanced and three backward-type provinces; among the six provinces in Central and South China, there are one advanced, four average, and one backward-type province; among the five provinces in Southwest China, all of them are average-type provinces; among the three provinces in Northeast China, there are two average-type provinces and one backward-type province; of the 5 provinces in the northwest region, there are 1 average-type province and 4 backward-type provinces. The development level of economic quality in the six major regions of China is shown in Figure 3. The spatial pattern of strong in the east and weak in the west, high in the south and low in the north, with east China as the leader, north and central-south China as the two wings, southwestern and northeastern China in the middle, and northwestern China at the bottom is very obvious, especially in terms of the ecological environment, the level of medical care and the level of education, the gap between the northwestern and northeastern China and the advanced regions is very large, which is a problem that needs to be resolved by focusing on the quality development in the future.

Table 2: The development level of high quality of regional economies in China

Region	A	B	C	D	E	F	G
South	0.5359	0.2629	0.3279	0.6806	0.3051	0.2719	0.4191
North	0.4232	0.2039	0.2673	0.412	0.2059	0.3123	0.2792
East	0.6336	0.3591	0.5164	0.6552	0.4205	0.3924	0.5259
Middle	0.4522	0.2212	0.2129	0.5464	0.1808	0.2094	0.2891
West	0.394	0.1437	0.1684	0.5026	0.1638	0.2723	0.2497
North	0.4828	0.296	0.4297	0.4202	0.2882	0.3801	0.3791
Northeast	0.3529	0.1702	0.2139	0.6063	0.1327	0.2265	0.2623
East	0.6333	0.3174	0.4621	0.5955	0.3115	0.3077	0.467
Midpart	0.4701	0.2373	0.2544	0.6611	0.3254	0.25	0.375
Southwest	0.4551	0.1479	0.1569	0.6511	0.208	0.2634	0.3169
Northwest	0.3407	0.1567	0.1569	0.3043	0.1309	0.293	0.173

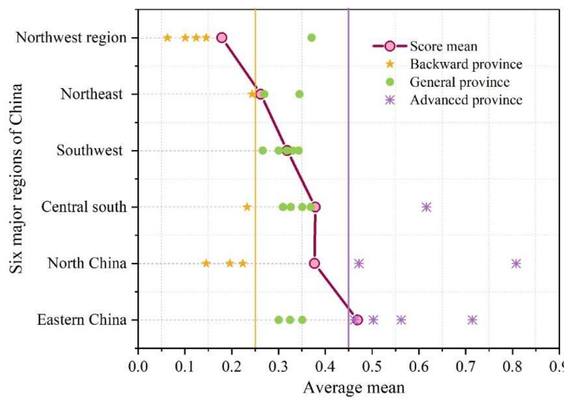

Figure 3: The development level of high quality of regional economy in China

III. B. Analysis of factors influencing the qualitative development of the economy

III. B. 1) Modeling

In this paper, the variable-intercept model was selected after the F test, and the Hausman test was used to select the establishment of a fixed-effects type. Therefore, this paper sets the benchmark regression model with fixed effects variable intercept as shown below:

$$\begin{aligned} GZ_{it} &= \beta_0 + \beta_1 Em_{it} + \beta_2 Fi_{it} + \beta_3 Tec_{it} \\ &+ \beta_4 Thi_{it} + \beta_5 Edu_{it} + \beta_6 Fp_{it} + \beta_7 Or_{it} + \mu_i + \varepsilon_{it} \end{aligned} \tag{18}$$

where i denotes cross-section individual $(1 \le i \le N)$, and t denotes time $(1 \le t \le T)$, in this paper, $n = 30$, $T = 10$; μ_i is the province fixed effect for the 30 provincial regions; and ε_{it} is the error term.

III. B. 2) Interpretation of variables and data sources

In this study, the index of the development level of economic quality measured by the entropy weight TOPSIS method (Gz) is used as the explanatory variable, including the panel data of 30 provinces in China from 2011 to 2022. The explanatory variables include environmental regulation (Em), financial development (Fi), technological progress (Tec): the proportion of R&D expenses, industrial structure (Thi): the proportion of the tertiary industry, the education level (Edu): the share of education expenditure in GDP, fiscal support policies (Fp):

the share of public finance expenditure in GDP, the degree of openness (Or): the total amount of imports and exports in relation to the share of each province's GDP. Environmental regulation (Em) data from China Ecological Environment Statistics Annual Report 2011-2022, financial development (Fi) data from Peking University's Digital Financial Inclusion Index, technological progress (Tec) and industrial structure $(ThiThi)$ and industrial structure (Thi) are from the Wind database. Other data are from the China Statistical Yearbook and the China Macroeconomic Database.

The results of the benchmark regression are shown in Table 3. At the national level, promoting technological progress, optimizing industrial structure, upgrading education, promoting financial development, increasing financial support and expanding foreign trade have a positive impact on economic quality development, while strengthening environmental regulation is detrimental to economic quality development. At the regional level, in the eastern region, the promotion of technological progress, optimization of industrial structure, enhancement of education and increased financial support, as well as the expansion of foreign trade, contribute to the promotion of economic quality development.

The positive coefficient of environmental regulation in the eastern region indicates that strengthening environmental regulation is beneficial to the development of economic quality in the region; in the central region, promoting technological progress, adjusting industrial structure, and improving education levels help promote economic quality development, but strengthening environmental regulation may be detrimental to the development of economic quality in the region; in the western region, promoting technological progress, optimizing industrial structure, improving education levels, promoting financial In the western region, promoting technological progress, optimizing industrial structure, improving education, promoting financial development, strengthening financial support, and expanding foreign trade all contribute to the promotion of quality economic development. In the western region, promoting technological progress, optimizing industrial structure, improving education, promoting financial development, strengthening financial support, and expanding foreign trade have all contributed to the quality of economic development.

The impact of environmental regulations varies across regions, mainly because environmental regulations may induce enterprises to reduce pollutant emissions, but they may also lead to a slowdown in the production rate of enterprises, resulting in a slowdown in the rate of economic growth, and thus, when weighed against the positive and negative impacts, strengthening environmental regulations may have a facilitating or inhibiting effect on the quality of economic development. The eastern region, which is usually richer in natural resources and has a more advanced industrial base, is better able to utilize environmental regulations to promote the development of green industries, and thus environmental regulations may have more of a facilitating effect on the eastern region. In contrast, the central and western regions may be lagging behind in resource allocation and industrial layout, and an overemphasis on environmental regulations may lead to cost pressures that are difficult for some firms to bear, thereby restricting the pace of economic development.

Table 3: Benchmark regression

Variable	Whole country	Eastern region	Central region	Western region
Tec	0.0136*	0.0429***	0.1246***	0.0642**
Thi	0.1934***	0.2236***	0.1605***	0.1958***
Edu	0.0151***	0.0138***	0.0193**	0.0117***
Fi	0.0137***	0.0000	0.0000	0.0133***
Em	-0.0694***	0.0052	-0.1015***	-0.0558***
Fp	0.0286**	0.1178***	0.0303	0.0377***
Or	0.0379	0.1662***	0.0186	0.3119*
-cons	-0.2307***	-0.1405***	-0.2334***	-0.2383***
R^2	0.9585	0.9889	0.8916	0.8475

Note: The values in brackets below the coefficients are t-values; ***, **, and * represent that the variable coefficients passed the 1%, 5%, and 10% significance tests, respectively.

III. C. Analysis of factors affecting the development of economic quality in China

From the score of economic quality development from 2014 to 2024, it can be seen that there are differences in economic quality development in different years, so what are the factors influencing economic quality development, this paper draws on the research results of Zhao Ruyu and Chang Zhongli to construct the following equation to estimate the factors influencing quality development. Where $score$ is the score of quality development, X_{it} is the factors affecting quality development, including the level of economic development, investment, consumption, innovation and government intervention.

$$score_{it} = \alpha_0 + \alpha_1 X_{it} + \epsilon_{it} \tag{19}$$

In this paper, we use GDP to measure the level of economic development, investment in fixed assets of the whole society to measure investment, total retail sales of consumer goods to measure consumption, the number of patents applied and authorized to measure innovation, and the proportion of tax revenue to GDP to measure the degree of government intervention. The data are obtained from the CEIC statistical database, and the basic descriptive statistics of each indicator are shown in Table 4.

Table 4: The basic description of economic development factors

Variable	Obs	Mean	SD	Min	Median	Max
Score	185	42.22	5.94	27.22	41.45	61.58
Quality improvement	185	7.82	1.88	1.90	7.51	13.17
Structural optimization	185	8.67	2.30	4.33	8.49	15.52
Kinetic energy conversion	185	1.79	1.91	0.02	1.01	8.18
Green low-carbon	185	6.93	1.56	2.91	6.93	10.62
Risk control	185	5.02	0.77	2.89	4.99	7.51
Improving people's livelihood	185	11.96	2.08	6.16	12.24	16.24
Government intervention	185	968.26	1342.04	0.12	0.36	4654.74
GDP	185	186.00	26586.59	21550.93	920.84	20864.69
The whole club will invest in fixed assets	185	18554.96	12477.96	1069.23	15079.64	55202.72
Total retail sales of consumer goods	185	2.13e+07	4.32e+07	364.50	12558.98	1.99e+07
Number of patent applications	185	58407.29	82778.35	146.00	32427.50	527390.01
Government intervention	185	968.26	1342.05	0.11	0.36	4654.73
Unit GDP waste water discharge	185	7.99	3.32	0.00	8.70	13.99

The results of the regression analysis of the factors affecting economic quality development are shown in Table 5. The results show that GDP plays an important role in the development of economic quality, regardless of which equation GDP has a positive effect on the score of economic quality development and is statistically significant, the impact of the investment in fixed assets of the whole society on the development of economic quality is not obvious and statistically insignificant, the number of patents granted does not have a significant impact on the development of economic quality and is statistically insignificant, government intervention and wastewater emissions per unit of GDP have a greater impact on the score of economic quality development and both are statistically significant. Government intervention and wastewater emissions per unit of GDP have a greater impact on the quality of economic development score and both are statistically significant.

Table 5: Analysis on factors of economic quality development

Variable	Score	Score	Score	Score	Score	Score
GDP	0.0000 ***	0.0000 ***	0.0000 ***	0.0000 ***	0.0000 ***	0.0000 ***
	-9.1366	-8.5044	-7.3619	-2.5298	-4.7829	-2.0884
The whole club will invest in fixed assets		-2.1603	-2.5195	1.1808	-6.8802	-8.0911
		-0.3404	-0.3996	-0.1903	-1.2498	-1.5708
Total retail sales of consumer goods			3.3875	4.3988	4.5905	2.8664
			-1.806	-2.3207	-2.8428	-1.8469
Number of patent applications				2.1496	7.5313	1.8981
				-2.4938	-0.9909	-2.5383
Government intervention					0.0063	-7.6294
					0.0071	-7.5818
Unit GDP waste water discharge						-0.517
						-4.57
-cons	35.4623	35.7449	35.6635	36.2759	30.0578	37.3961
	-47.1492	-31.3303	-31.4399	-31.7605	-23.7093	-18.8394
N	185	185	185	185	185	185

IV. Conclusion

This study constructs a comprehensive evaluation index model of economic quality development, and uses the AHP-EWM-TOPSIS method to deeply analyze the level of economic quality development of the whole country, regions such as the East, the Middle East and the West, as well as provinces, paying attention to the characteristics of their spatial and temporal changes, and finally discusses the influencing factors of China's economic quality development.

(1) The overall level of China's economic quality development is not high, and spatial differences are very obvious. On the whole, the level of economic quality development is higher in the southern region, with an obvious gap between the north and the south; the level of economic quality development is higher in the eastern region, which is substantially ahead of the central and western regions, but the gap between the central and western regions is not large. Under the provincial perspective, Beijing, Shanghai and Guangdong have a higher level of economic quality development, while Gansu, Qinghai and Xinjiang have a lower level of economic quality development.

(2) Technological progress, industrial restructuring, education level improvement, financial expenditure increase, and foreign trade development have a positive impact on the quality development of the national and regional economies.

(3) GDP plays an important role in China's economic quality development in the new era, and if GDP does not have a reasonable growth rate, economic quality development is difficult to realize, while government intervention plays an important role in this process.

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