Research on the Evaluation of High-Quality Economic Development Based on Factor Analysis

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Based on the five development concepts of innovation, coordination, green, openness, and sharing development, and using factor analysis, this paper evaluates comprehensively the level of high-quality economic development in 31 provinces in China in 2017. The study reveals the five dimensions and overall status of high-quality economic development in different provinces, analyses the spatial development characteristics of different dimensions, and proposes related policy recommendations.

Keywords: High-quality Economic Development, Five Development Concepts, Factor Analysis

Introduction
In 2017, the 19th CPC National Congress Report stated that the Chinese economy should shift to a stage of high-quality development. High-quality economic development is the fundamental requirement for development both now and in the future period which is receiving increasing and wide attention. Therefore, based on the five development concepts of innovation, coordination, green, openness and sharing, this paper evaluates the high-quality economic development level of 31 provinces in China, which has certain theoretical and practical significance.

Overview of high-quality economic development
At present, there are relatively few systematic and quantitative studies of high-quality economic development. Jin B and Ren B P et al. studied the high-quality economic development qualitatively. Chen S Y and Feng M et al. explored the influence of environmental factors on high-quality economic development from different angles. Li X H and Feng M et al. used factor analysis to explore the influencing factors of a single area of economic development. Wei M et al. used the TOPSIS method to construct a measurement system for high-quality economic development. Feng M et al. used the DEA method to measure the efficiency of industrial green transformation of 30 provinces in China.

Evaluation system construction
This paper adopts the factor analysis method. The core idea is to reduce the dimensionality of multiple original variables \(X_1, X_2, ..., X_n\) with strong correlations into a few common factors \(F_1, F_2, ..., F_m\) with no correlation and containing more information about the original variables. Then, the original variables can be represented by a linear relationship of the common factors. Based on the five development concepts and the principles of data availability, operability, and comprehensiveness, this paper takes 31 provinces in China as its evaluation target and selects the relevant indicator data of each province in 2017. Starting from the five dimensions of innovation, coordination, green, openness, and sharing development, the evaluation system consists of 14 first-level indicators and 25 second-level indicators, shown as Table 1. The data of the evaluation indicators are from the 2017 China Statistical Yearbook and the statistical yearbooks of provinces. The data are normalised, and all the reverse index data are negatively normalised.

Empirical analysis
This paper takes innovation development as an example to introduce the evaluation process of factor analysis. The evaluation process of the other four criteria layers is similar. Firstly, the relevant index data are imported into SPSS 23.0 software for a KMO test and a Bartlett test. The Output shows that the value of KMO is 0.716. The Bartlett test value is 118.831, and the sig value is 0.000. Both of them

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indicate that the original variables $X_1$–$X_5$ are suitable for factor analysis. Secondly, principal component analysis is used to extract the common factor with an eigenvalue greater than 1. Moreover, the common factor is rotated by the maximum variance method, and the scores of each common factor are calculated by the regression method. By dividing the variance contribution rate of each common factor by the cumulative contribution rate as the weight, this paper can calculate the comprehensive score of each province's innovation development. In terms of innovation development, two common factors of $F_1$ and $F_2$ were extracted that contained 90.106% of the information expressed by the original variables $X_1$–$X_5$. The variance contribution rates of $F_1$ and $F_2$ were 61.490% and 28.616%, respectively. Therefore, the weights of $F_1$ and $F_2$ are 68.242% (i.e., 61.490% divided by 90.106%) and 31.758% (i.e., 28.616% divided by 90.106%), respectively.

Finally, according to the common factor score coefficient table, shown as Table 2, the relationship between the variables (X), common factors (F), and Five development dimensions (Y) can be listed as follows:

<table>
<thead>
<tr>
<th>Target Layer</th>
<th>Criteria Layer</th>
<th>Primary Indicators</th>
<th>Secondary Indicators</th>
<th>Attributes</th>
<th>Symbol</th>
</tr>
</thead>
</table>
| Innovation   | Y_1            | Innovation inputs  | Number of R&D personnel + $X_1$
R&D expenditure / GDP + $X_2$
Government science and technology expenditures / general budget expenditures + $X_3$
|              |                | Innovation outputs | Number of per capita valid invention patents + $X_4$
Technical market turnover / GDP + $X_5$
Urban population ratio + $X_6$
|              |                | Urban and rural    | Urban and rural per capita income ratio - $X_7$
|              |                | Industry           | Third industry output value / second industry output value + $X_8$
Labour compensation / GDP + $X_9$
|              |                | Income and         | Final consumption expenditure / GDP + $X_{10}$
expenditure | Per capita water consumption - $X_{11}$
Unit GDP power consumption - $X_{12}$
Unit GDP wastewater discharge - $X_{13}$
Unit GDP SO$_2$ emissions - $X_{14}$
Unit GDP general industrial solid waste discharge - $X_{15}$
Number of mobile phone user + $X_{16}$
Number of mobile internet user + $X_{17}$
Total import and export / GDP + $X_{18}$
Total foreign investment / GDP + $X_{19}$
Education expenditure / General public budget expenditure + $X_{20}$
Mortality rate - $X_{21}$
Per capita public library inventory + $X_{22}$
Resident per capita disposable income + $X_{23}$
Resident per capita consumption expenditure + $X_{24}$
Social security expenditures / General public budget expenditure + $X_{25}$
|              |                | Resource consumption | Per capita water consumption - $X_{11}$
Unit GDP power consumption - $X_{12}$
Unit GDP wastewater discharge - $X_{13}$
Unit GDP SO$_2$ emissions - $X_{14}$
Unit GDP general industrial solid waste discharge - $X_{15}$
Number of mobile phone user + $X_{16}$
Number of mobile internet user + $X_{17}$
Total import and export / GDP + $X_{18}$
Total foreign investment / GDP + $X_{19}$
Education expenditure / General public budget expenditure + $X_{20}$
Mortality rate - $X_{21}$
Per capita public library inventory + $X_{22}$
Resident per capita disposable income + $X_{23}$
Resident per capita consumption expenditure + $X_{24}$
Social security expenditures / General public budget expenditure + $X_{25}$

Table 1 — The specific indicators of the evaluation system

Table 2 — The coefficient of the common factors’ scores in innovation development

<table>
<thead>
<tr>
<th>Variables</th>
<th>$F_1$</th>
<th>$F_2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$X_1$</td>
<td>0.358</td>
<td>-0.249</td>
</tr>
<tr>
<td>$X_2$</td>
<td>0.339</td>
<td>-0.166</td>
</tr>
<tr>
<td>$X_3$</td>
<td>0.197</td>
<td>0.279</td>
</tr>
<tr>
<td>$X_4$</td>
<td>0.231</td>
<td>0.196</td>
</tr>
<tr>
<td>$X_5$</td>
<td>-0.166</td>
<td>0.758</td>
</tr>
</tbody>
</table>

$F_1 = 0.358X_{11} + 0.339X_{12} + 0.197X_{13} + 0.231X_{14} - 0.166X_{15}$

$F_2 = -0.249X_{11} - 0.166X_{12} + 0.279X_{13} + 0.196X_{14} + 0.758X_{15}$

$Y_{ii} = (61.490\% F_{1i} + 28.616\% F_{2i}) / 90.106\%$  

Among them, i indicates the province. So, $F_{1i}$ and $Y_{ii}$ represent the score of the common factor $F_1$ and the score of the innovation development of the province i, respectively.

This paper assumes that the five dimensions have the same weight, which is equal to 20%. Therefore, the scores and rankings of 31 provinces in $Y_1$–$Y_5$ and HQED can be calculated, and the rankings are shown in Table 3.
Conclusions

Through empirical analysis, the following conclusions can be drawn: In terms of innovation, openness, and high-quality economic development, on the one hand, the scores in the eastern regions, such as Beijing and Jiangsu, are generally higher than are those in the western regions, such as Xinjiang and Qinghai. On the other hand, the scores in the coastal regions, such as Guangdong and Shanghai, are generally higher than are those in the inland regions, such as Xizang and Ningxia. There are relatively significant regional differences and uncoordinated developments, with the characteristics of ‘east high, middle flat, and west low’ and ‘coastal high and inland low’. In terms of coordinated development, with a higher urbanisation rate, faster development of tertiary industry, and higher final consumption expenditure, Beijing ranks highest. Uncoordinated industrial development, a low proportion of initial distribution of labour compensation, and a low urbanisation rate are the main reasons for the low scores of some provinces. In terms of green development, the level of education and culture, and social security are the main reasons for the low scores of some provinces.

Recommendations

This paper proposes recommendations on how to promote high-quality economic development in China, as follows: Firstly, it is necessary to provide appropriate support for the development of science and technology innovation in the central and western regions, accelerate the full coverage of the mobile Internet, and promote the ‘Belt and Road’ strategy to reduce regional and urban–rural coordinated differences. Secondly, it is necessary to change the mode of development, optimise the economic structure, improve economic efficiency, and reduce the energy consumption and pollutant emissions per unit of GDP. Finally, it is necessary to improve the quantity and quality of supply of basic, service, and inclusive public services, such as health care, education, and social security. Moreover, it is important to increase the income level of residents and the proportion of initial distribution to realise sharing of the development results by all.

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References


