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An Application of Factor Analysis in the Evaluation of Country Economic Rank

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Abstract

The economic parameters play an important role in economic growth and it also affects economic performance of a country. This paper described the basic principles of factor analysis, and used this method to perform a comprehensive analysis and evaluation of economic development of 20 countries on 21 economic parameters. The performance of our work is evaluated using IMF dataset for 20 countries and result shows the economic rank of countries (Kuwait, Germany, Iceland, Belgium, Denmark, Taiwan, Qatar, Ireland, Sweden, Luxemburg, Austria, Singapore, Norway, Netherland, Hong Kong, Brunei, us, Switzerland, Canada, and Australia). We saw that our calculated rank and the rank provided by world ranking list is almost same which confirms that it is successful to apply factor analysis into countries economic evaluation.

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Keywords: Factor analysis; Economic parameters; Country economy; Comprehensive analysis; Economic development.

1. Introduction

With the development of economy, the competition between countries is increasing. We analyze the competitiveness between countries on the levels of economic development for a comprehensive, objective and systematic evaluation. Every parameter reflects certain information of evaluation from different angles and perspectives, but there are some relationships between these various parameters, then the reflected information will generate overlapping, resulting in the distortion of statistical analysis[1]. Factor analysis method can effectively overcome these problems and make a significant evaluation of the level of economic development between countries. This paper takes data of 20 countries as an example to introduce the application of factor analysis in comprehensive evaluation of country economic development. We analyze the influential factors of countries competitiveness to provide support and protection for the development of countries.

2. Basic Principles of Factor Analysis Method

Factor analysis[2,3] is used to uncover the latent structure (dimensions) of a set of variables. It reduces attribute space from a larger number of variables to a smaller number of factors. Factor analysis has a variety of applications such

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as an assessment of underlying relationships or dimensions in the data, and there placement of original variables with fewer, new variables.

The factor analysis model[4,5] expresses each variable as a linear combination of underlying *common factors* $f1, f2, \ldots, fm$, with an accompanying error term to account for that part of the variable that is unique (not in common with the other variables). For $y1, y2, \ldots, yp$ in any observation vector **y**, the model is as follows:

$$\begin{cases} y1 - \mu 1 = \lambda 11\ f1 + \lambda 12\ f2 + \cdots + \lambda 1m\ fm + \varepsilon 1 \\ y2 - \mu 2 = \lambda 21\ f1 + \lambda 22\ f2 + \cdots + \lambda 2m\ fm + \varepsilon 2 \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \\ yp - \mu p = \lambda p1\ f1 + \lambda p2\ f2 + \cdots + \lambda pm\ fm + \varepsilon p \end{cases} \tag{1}$$

Ideally, m should be substantially smaller than p; otherwise we have not achieved a parsimonious description of the variables as functions of a few underlying factors. We might regard the f's as random variables that engender the y's. The coefficients λij are called *loadings* and serve as weights, showing how each yi individually depends on the f's.

3. Factor Analysis to Evaluate Ranking of Countries

This paper chooses the 20 countries as a sample from IMF dataset[6], and applies factor analysis to make a comprehensive evaluation of their economic development. We use the SPSS software to calculate the correlation coefficient matrix of 15 parameters and analyze these parameters which present a strong correlation among them. It indicates that the information extracted from 15 parameters have strong relation. Therefore, the number of parameters can be reduced and classified by factor analysis, so that the final estimation of results will be more appropriate.

3.1 Economic parameters

Select 15 parameters:

V_1 - Gross domestic product per capita current prices (National currency); V_2 - Implied PPP conversion rate (National currency per current international dollar); V_3 - Total investment (Percent of GDP); V_4 - Gross national savings (Percent of GDP); V_5 - Volume of Imports of goods (Percent change); V_6 - Volume of exports of goods (Percent change); V_7 - Unemployment rate (Percent of total labor force); V_8 - Employment (Persons); V_9 - Population (Persons); V_{10} - General government revenue (National currency); V_{11} - General government total expenditure (National currency); V_{12} - General government net lending/borrowing (National currency); V_{13} - General government structural balance (National currency); V_{14} - General government gross debt (National currency); V_{15} - Current account balance (U.S. dollars).

3.2 Evaluation of correlation coefficient matrix to test the appropriateness of factor analysis

Before performing factor analysis need to evaluate and ensure the validity and reliability of the data[7]. Reliability refers to the consistency degree of measurement results. We measure the reliability of the data using Cronbach coefficient α. Validity refers to the closeness of the measured values. We measure data's validity using KMO and Bartlett's test of Sphericity.

We use SPSS software to analyze the data reliability and validity. Results show that α coefficient value is 0.807 which indicates data reliability is good. KMO statistic value is 0.699, indicating factor analysis is relatively suitable. Significance probability of Bartlett's test of Sphericity is $0.000 < 0.01$, rejects the original hypothesis which indicates that the parameters are related, so it is suitable for factor analysis. The results of test are shown in Table 1.

From correlation matrix shown in Appendix A, it is analyzed that most parameters have relatively strong correlation, so it is necessary to make a factor analysis.