Factor Analysis Revisited: A Study of Structural Change in a Growth Perspective

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Abstract: This study refers to the agricultural growth pattern in the more and less developed regions of peninsular India during 1955/56-1978/79. The effective use of factor analysis for planning appropriate strategies is empirically demonstrated. The main feature of the study is the use of factor analysis for two distinct periods of development in the two regions. Differential rates in agricultural growth were mostly due to the imbalanced pattern of factor mix. Agricultural growth was led by irrigation and associated variables, while rainfed technology has yet to contribute to agricultural growth. Less developed regions owed their slower rate of growth in the earlier period to lack of appropriate policies to exploit their irrigation potential and provide associated services.

Introduction

To understand development, one must use intralinked large matrices and simplify them to a size that can be understood, which can now be done more easily and cheaply through knowledge of multivariate analysis and the availability of computers. This changed methodology has reduced the number of *ceteris paribus* conditions and thus enabled researchers to incorporate all the important quantifiable data. Despite these improvements, difficulties are often encountered in properly identifying the underlying dimensions and in interpreting the exact relationships of individual variables with the associated dimensions. The present study tries to suggest some improvements in the use of factor analysis with empirical evidence.

Main Emphasis

Factor analysis is used to identify underlying dimensions of a complex constellation (matrix) of variables. The usual practice is to describe important dimensions exclusively for a static situation, which is justified so long as orthogonality exists not only among dimensions but also among sets of variables having higher factor loadings on different dimensions. But encountering such situations is almost impossible. Furthermore, the growth pattern could be properly identified only when the time element is introduced by considering the associations of a given set of variables over time while developing the initial correlation matrix. This can be further extended to compare regions.

This study mainly considers the associations among variables over two distinctive periods and their impacts on the performance of the agricultural sector in more and less developed regions. In order to introduce more mathematical and economic logic into the use of the technique, the assumption of orthogonality of sets of variables belonging to different dimensions is relaxed. This is justified because almost all the variables will have nonzero factor loadings on all the extracted dimensions. In other words, the variables are given more importance in explaining the growth phenomenon, keeping dimensions in the background. These objectives have been achieved in this study through incorporation of the time element and comparison of two periods' growth performances in more and less developed regions.

Data and Method

This study relates to Karnataka State in the southwestern part of the Deccan Peninsula in India. Because of the reorganization of states in India, comparable data are available only from 1955/56. Hence, the period 1955/56–1978/79 was chosen and further divided into two periods—1955/56–1966/67 and 1968/69–1978/79. With the district as the unit of reference, the data were collected from various official sources dealing with rainfall, land use and cropping patterns, use of irrigation water, fertilizer, manure, and plant protection chemicals, infrastructural and institutional facilities, pattern of land holdings, and crop output and prices.

In preliminary studies with various measures such as the agricultural activity index and Oshima's index of inequality, the growth of output value indicated that two regions existed—a more developed region and a less developed region. One district from each of the regions was selected for comparison over the two periods. Since no definite hypotheses were to be tested, an exploratory type of factor analysis was used, incorporating all the available and quantifiable relevant information. The factor analysis model in matrix form used in this study was:

$$X_{(n\times N)} = A_{(n\times m)} \times F_{(m\times N)},$$

where X is a matrix of zero-order correlation (over time), A is a matrix of factor loadings, F is a matrix of dimensions, N is the number of years (12 in the first period and 11 in the second period), and n is the number of variables (40 in the first period and 50 in the second period).

The principle-axes method was followed to extract m dimensions. However, only the first two dimensions were considered for interpretation. The initial unrotated orthogonal factor matrix was used since it better explained variation than varimax rotation.

Changes Over the Period

In the more developed region, the factor loadings on the first two dimensions together explained 67 percent of the variation in the variable matrix. The first dimension was identified as "irrigated or modern technology." This was the important dimension in the region (with 52 percent of the variation being explained) during the first period. This dimension indicated the simultaneous expansion of areas under important crops of the region, improvements in irrigation facilities, and increases in the labour force. The second dimension, which was of lesser importance (accounting for 14 percent of total variation) represented "rainfed technology." No conspicuous change occurred from first to second period in the more developed region. In other words, the more developed region had stabilized in its performance during the first period, and the improvements in factor mix during the second period were marginal.

In the less developed region, a change in pattern over the two periods did occur. In the first period, a clear polarization of variables on the first dimension was evident, and no positive association existed among key variables like irrigation, infrastructural facilities, total area sown, or area under important crops. Nor did the second dimension exhibit any recognizable pattern among important variables. Thus, the two dimensions, which together explained 59 percent of the variation, indicated that the policies failed to synchronize factors during the first period. In contrast to the more developed region, the pattern of factor loadings had undergone a thorough change over the period in the less developed region. In the second period, not only did the percentage variation explained (72) improve, but also positive associations existed among variables similar to those observed in the more developed region.

This evidence proves that the higher growth rate in the less developed region was achieved by achieving a proper mix among factors influencing agriculture, and the rate was lower in the more developed region as it reached this level during the first period. This clearly highlights the importance of a coordinated approach and the futility of development programmes that emphasize individual components.

Conclusions

This study refers to the agricultural growth pattern in the more and less developed regions of peninsular India during 1955/56-1978/79. The effective use of factor analysis for planning appropriate strategies was empirically demonstrated. The main feature of the study is the use of factor analysis for two distinct periods of development in the two regions.

The differential rates in agricultural growth were mostly due to the pattern of factor mix. The higher growth rates can be achieved even in the less developed region if a coordinated approach is made with appropriate emphasis on all the key variables. Furthermore, in the more and less developed regions, agricultural growth was led by irrigation and associated variables, and rainfed technology has yet to contribute to agricultural growth. The hitherto less developed regions were in that state mostly because of lack of planning to exploit their irrigation potential and provide associated services.

Note

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