A Study on National Technology & Science Competitiveness Indicators

Abstract(Chinese Version)

在政府與社會各界一致認同提升我國科技競爭力係提高我國整體國際科技競爭力主要動力的共識下，究竟目前我國整體科技競爭能力如何？客觀衡量我國科技水準的工具為何？如何制定相關政策以輔助提升科技競爭力？又如何提升科技競爭力方能提升國家競爭力？此種種問題在在突顯出建立國家科技競爭力指標體系的必要性與迫切性。此體系必須是能夠完整長期表達我國科技之水準與能力，並具有長期觀察的功能。

本子計畫第一年研究的主要目的即是發現建立我國科技發展綜合指標之方法，此方法是較能夠有理論基礎支持，以作為未來我國相關單位建立綜合指標之參考依據。本研究嘗試多組實證研究，得出在資料取得無慮及指標系統架構完整的情形下，利用統計因素分析法及主成份分析法，可解釋及得出綜合指標各子成份之權數。此結果與預期達成目標一致，待資料齊全後，可提供未來編製綜合性指標之參考。

Abstract(English Version)

When government and society all agree that enhancing our science & technology competitiveness is the main drive of increasing our overall international science & technology competitiveness, what is our current overall science & technology competitiveness ability? What is the tool to objectively measure our science & technology level? How do we legislate related polices to assist science & technology competitiveness enhancement? How do we improve science & technology competitiveness so that we can also enhance national competitiveness? These questions are implying the necessity and imminence of establishing indicators system for national science & technology competitiveness. This system must be able to express capability and level of our science & technology as well as observe in the long run.

The main purpose of this project is to find a theoretical way for establishing an comprehensive indicator with respect to domestic technology development. With the theoretical background, the comprehensive indicator is not only for self comparison every year, but also for international comparison. After many empirical researches, we think the factor analysis and the principal component analysis can be a theoretical way to set up the weight for the comprehensive indicator.

Focus of the Study

Due to the emphasis on the development of Science & Technology from the Taiwanese government, the capacity of innovation in this field is becoming more important to Taiwanese industries in recent years. Hence, the capacity of innovation has a significant impact on the nation's technology competitiveness. But, what is the current status of technology development among Taiwan's various industries? How is the industries' aptitude for innovation in this field? How do the Taiwanese government legislate relevant policies to assist its industries to enhance the capacity of innovation? These questions are essential to the establishment of indicator system for industries in terms of the innovation. This indicator system should be able to reveal the current status of technological development. It should also be able to observe this technological development in the long run.

The main purpose of this project is to establish a set of comprehensive indicators to record the industries' aptitude for technological innovation; therefore, these indicators can be a standard for enhancing the nation's technological development. Further, this indicator system not only is for self comparison, but also provides a guideline for policy makers and academic researchers to form forecasting models or to perform some empirical research.

This project is planning to analyze extensively the domestic industries' aptitude for innovation. By establishing a set of technological innovation indicators for Taiwanese industries, these indicators can provide a guideline for policy legislative. This set of indicators can further relate to the development process of technology among various industries.

Methodology

Based on both Factor Analysis and Principal Component Analysis, this project derives a set of comprehensive indicators from various individual indicators, which consist of R&D, manpower, productivity among the US, Taiwan, Japan, and Korea.

The Factor Analysis

This Analysis is an interdependence analysis technique. Its main function is to express the original data structure by using a less number of dimensions. Meanwhile, this technique enables the user to maintain a majority of information contained in the original data structure. Further, this technique possess two purposes: the exploratory factor analysis and the confirmatory factor analysis. The former purpose aims to establish a new theory by reducing a majority of variables and, then,

using the common properties to find out the potential structure. This purpose is what the Factor Analysis focuses on in this project.

The Principal Component Analysis

The main purpose of this analysis is to reduce data and offer interpretations. That is, to regroup and convert many original dependent variables into a less number of stochastic variables. These stochastic variables can then explain a majority of information contained in the original variables. Therefore, the principal components with a strong orientation in offering explanations can develop into comprehensive indicators.

Main Findings

The results of the Factor Analysis with regard to the indicator of Science Technology will be interpreted in the first three findings. While, the last finding is the interpretation for the results of Principal Component Analysis.

1. The Science Technology indicator consists of 74.8% of the national technology standard and 25.3% of the potential aptitude for technology development. In terms of formula:

$Y = 0.7475*F1 + 0.2525*F2$, where

$F1 = 0.2*VAR1 + 0.16*VAR2 + 0.22*VAR3 + 0.25*VAR5 + 0.17*VAR6$
$F2 = VAR4$

Y is the indicator of Science Technology. F1 is the standard of the national technology. F2 is the potential aptitude for technology development. VAR1-6 is equal to variables.

2. The Science Technology indicator consists of 87.5% of the national R&D level and 12.5% of the manpower R&D level. In terms of formula:

$Y = 0.875*F1 + 0.125*F2$, where

$F1 = 0.12*VAR1 + 0.18*VAR2 + 0.13*VAR3 + 0.11*VAR4 + 0.13*VAR5 + 0.15*VAR7 + 0.18*VAR10$
$F2 = 0.05*VAR6 + 0.45*VAR8 + VAR9$

Y is the indicator of Science Technology. F1 is the national R&D level. F2 is the manpower R&D level. VAR1-10 is equal to variables.

3. The Science Technology indicator consists of 50.0% of the national technology development, 25.0% of technology application & development, 15.0% of the

research for the foundation of industries, and 10.0% of private R&D and its application. In terms of formula:

$Y = 0.4973*F1 + 0.2471*F2 + 0.1472*F3 + 0.1084*F4$, where

$F1 = 0.19*VAR1 + 0.23*VAR6 + 0.30*VAR9 + 0.27*VAR10$
$F2 = 0.45*VAR4 + 0.55*VAR5$
$F3 = 0.37*VAR2 + 0.63*VAR3$
$F4 = 0.51*VAR7 + 0.49*VAR8$

Y is the indicator of Science Technology. F1 is the national technology development. F2 is the technology application & development. F3 is the research for the foundation of industries. F4 is the private R&D and its application. VAR1-10 is equal to variables.

4. Based on the results of Principal Component Analysis, the indicator of Science Technology consists of principal component 1 and principal component 2. The principal component 1 suggests that the indicator focuses on the R&D expenditures; while, the principal component 2 relates to the manpower for R&D and its capacity. However, due to the high percentage of principal component 1 in the equation (79.75%), the indicator is mainly formed by the principal component 1. In terms of formula:

$$Y = 0.124*VAR1 + 0.124*VAR2 + 0.124*VAR3 + 0.125*VAR4 + 0.003*VAR5 + 0.1*VAR6 + 0.12*VAR7 + 0.1*VAR8 + 0.09*VAR9 + 0.09*VAR10$$

Policy Implications

There is a close relationship between technological development and economic performance. Hence, how to improve Taiwan's technology competitiveness and assist the nation's industries through the relevant government policies are going to be the two major challenges for turning Taiwan into a "technological island."

This project concludes four comprehensive indicators with regard to Science & Technology: the indicator of Science Technology, the indicator of R&D capacity, the indicator of private R&D, and the indicator of R&D expenditure.

As comparing with the other three nations (the US, Japan, and Korea), these four indicators reveal some implications. The United States wins first place in the performance of these four indicators. Japan is second to the US while Korea is in the third place except for the indicator of Science Technology. In other words, Taiwan is in the last place with regard to the performance of all the indicators except for the indicator of Science Technology. Accordingly, Korea should be Taiwan's main adversary in terms of the nation's technology competitiveness because Taiwan's

technological development is still far behind that of the US and Japan.

Self Evaluation

The expected result of this project has been achieved. It could provide policy legislators and academic researchers a reference for empirical research or forecasting model establishment.

Reference

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