TECHNOLOGY DEVELOPMENT PROGRAM PERFORMANCE EVALUATION: A DEA APPLICATION

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ABSTRACT

Taiwan is prominent in providing manufacturing services to global technology giants. The technology industry is a major driving force in Taiwan's economic development. According to this, the Taiwan government employed technology development programs (TDPs) to stimulate industrial technology R&D to enhance industry competitiveness. In this paper, the Data Envelopment Analysis (DEA), a multiple criteria and nonparametric approach for evaluating the relative efficiency of decision making units (DMUs) that use multiple inputs to produce multiple outputs, is used to evaluate the relative managerial efficiency of TDPs. The findings of this research can help the Taiwan government understand the performances of TDPs and make resource allocation better in the future.

INTRODUCTION

To enhance industrial technology and accelerate industry improvement, from 1979, the Ministry of Economic Affairs (MOEA) of Taiwan began setting aside budgets to request research institutions to participate in industrial technology research and development projects. In 1993, the Department of Industrial Technology (DOIT) was established to implement the Technology Development Program (TDP). The TDP objectives are to stimulate the development of knowledge intensive industry, upgrade the R&D capabilities of research institutions, reinforce innovative R&D, and encourage the creation and circulation of industrial technology. The TDP performance evaluation is critical to resource allocation in the next year. Therefore, a comprehensive measurement is necessary for DOIT to understand the performance in each field to adjust government industry policies. This task is carried on by the TDP review committee and the members are experts from different field. However, it would cost a lot of time to judge TDP performances. Besides, we should consider the relationship between the input and output. Furthermore, different input and output indicators should be taken into consideration to determine the performance index more accurately because the relations between inputs and outputs are complicated. In view of these issues, we adopted Data Envelopment Analysis (DEA) as our methodology to analyze TDP performances. DEA is a multiple criteria and nonparametric approach for evaluating the relative efficiency of decision making units (DMUs) that use multiple inputs and multiple outputs to determine a performance index. Charnes et al. in 1978 first proposed DEA to evaluate the efficiencies of DMUs. In this paper, we determine managerial efficiency using different models including CCR, A&P, and cross efficiency models.

DATA ANALYSIS

The communication and optoelectronics field has better performance on average. Communication and optoelectronics had the best performance in 2002 which was referred 9 times. In 2002, Taiwan began to play an important role in manufacturing mobile phones for Motorola, Ericsson, and Philips etc. Taiwan's TFT-LCD industry is only second to Korea in production. We analyzed sixteen DMUs in CCR efficiency by A&P models to differentiate their performances and the first five rankings were IF(2003), CT(2001), CO(2002), IF(2002), MC(2001). This implied that innovation foresight seemed to have better performances than the other fields. We analyzed the efficiencies of TDPs using the cross efficiency model, which differs from the self-appraisal models. The cross efficiency model is a peer-appraisal type. The efficiency index is the performance evaluation of a DMU with respect to the optimal input and output weights of other DMUs and can rank DMUs, specifically the efficient ones, to complement CCR efficiency in assessment.

RESULTS AND DISCUSSIONS

This paper applied three DEA models to evaluate the performances of TDPs in six fields from 1999 to 2003. According to our empirical results, the communication and optoelectronics field had better performances than the other fields on average. Taiwan has good foundation to sustain our competitive advantages in communication and optoelectronics field and government should keep allocating enough resources to this field. We found that A&P and cross efficiency could tell the differences between CCR efficiency DMUs clearly. However, the CCR model was essential to them. With CCR results, we have a basic understanding of the performance evaluation for TDPs. Furthermore, we have a comprehensive understanding of the performance evaluation for TDPs with A&P and cross efficiency results. We also found the biotechnology and pharmaceutical field did not have good performance compared to the other fields. There are two reasons for this phenomenon. First, the biotechnology and pharmaceutical field in Taiwan is still in the introduction period compared to other fields, which are in the growth or mature periods. Besides, the research output needs more time to produce world class results. The biotechnology and pharmaceutical field research results must wait a long period to produce repeatable results. For example, it takes about seven years to put a new drug into the market according government regulations. The scope of the biotechnology and pharmaceutical field is large and Taiwan may have to make good use of its limited resources to focus on some topic to have better performances. That is, the government should make sure the development direction before allocating more resources in this field

CCR, A&P, and Cross Efficiencies

No.	DMU	CCR	A&P	Cross Efficiency
1	CO(2003)	1.0000	1.1135	1.2425
2	MA(2003)	1.0000	1.3932	0.9877
3	MC(2003)	1.0000	1.2569	0.9341
4	BP(2003)	0.7562	0.7562	0.5033
5	CT(2003)	0.9395	0.9395	0.5787
6	IF(2003)	1.0000	2.0016	0.6556
7	CO(2002)	1.0000	1.8232	1.4492
8	MA(2002)	1.0000	1.1558	1.2504
9	MC(2002)	1.0000	1.0230	0.7929
10	BP(2002)	0.7404	0.7404	0.4032
11	CT(2002)	1.0000	1.3308	0.6097
12	IF(2002)	1.0000	1.4741	0.6616
13	CO(2001)	1.0000	1.1663	1.3890
14	MA(2001)	1.0000	1.4101	1.0864
15	MC(2001)	1.0000	1.4711	0.8954
16	BP(2001)	0.7661	0.7661	0.3707
17	CT(2001)	1.0000	1.9802	1.3296
18	CO(2000)	0.9695	0.9695	2.3875
19	MA(2000)	0.9129	0.9129	1.5695
20	MC(2000)	0.9353	0.9353	1.1692

21	BP(2000)	0.6881	0.6881	0.4728
22	CT(2000)	1.0000	1.0547	0.4879
23	CO(1999)	0.9643	0.9643	1.6256
24	MA(1999)	1.0000	1.4660	1.1573
25	MC(1999)	1.0000	1.2592	0.8598
26	BP(1999)	0.8363	0.8363	0.3444
27	CT(1999)	0.9304	0.9304	0.3437

CO: communication and optoelectronics
MA: machinery and aerospace
MC: material and chemical engineering
BP: biotechnology and pharmaceutical
CT: common technology
IF: innovation foresight

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