Research on the Effect of Informatization on Innovation Capability

Xian Wang
School of Management
Guangxi University of Science and Technology
Liuzhou, China
E-mail: 610268609@qq.com

Shiping Guan
School of Management
Guangxi University of Science and Technology
Liuzhou, China

Guilian Liu
School of Management
Guangxi University of Science and Technology
Liuzhou, China

Abstract—**Informatization construction exerts an important effect on economic and social development, and the constant improvement of the informatization level also makes a remarkable effect. In this paper, by analyzing the contents of informatization and innovation capability, structuring an evaluation index system of informatization affects innovation capability, and building efficiency regression model, and using data envelopment analysis and multiple regression analysis to analyze the indexes. Research shows: the condition of informatization development, informatization human resource and information consumption have positive impacts on the condition of patent application which is to measure the innovation capability.**

Keyword—informatization; innovation capability; evaluation index; DEA

I. INTRODUCTION

Informatization is an objective trend of the economic and social developmen in the world. It is also an important sign that weighs the modernization of a country and region. With the improvement of the informatization, social economic activities take place fundamental reform. Meanwhile, it also exerts an important influence on innovation activities' efficiency and effectiveness. Our country's informatization level advances in a rapid speed, but there is still a gap compared with developed countries. And the capability of independent innovation is relatively weaker. The "double dilemma" fact that lack of independent innovation and the lower informatization level to a certain extent have affected the sustained and rapid growth of China's economy. It is a problem to be solved that how to utilize informatization to enhance technology innovation capability.

At present, the research on informatization mainly focus on information level measure and the relation of information level and economic growth, but the research on the relation of informatization and innovation capability is not enough. Besides, most research on the relation of informatization and innovation capability focus on microcosmic field, however, the research from macroscopic field is little. Given this, this paper explore the effect of informatization on innovation capability through constructing the evaluation index system and evaluation model. And then we can provide theory reference which enhance independent innovation capability and promote our country's informatization construction.

II. CONSTRUCTION OF EVALUATION INDEX SYSTEM

A. Informatization Index

According to the twenty "national informatization index" which is published on national informatization index working conference in 2001,and the research results conducted by International Statistical Information Center of National Bureau of Statistics China, and combined with the views of related researchers, the paper chooses the most typical four indexes to measuring the informatization level. And the information environment is divided into two aspects of hard and soft information environment. The hard information environment is the material basis for informatization construction, and it consists of informatization development environment and informatization human resource environment. The soft information environment corresponds with hard information environment. It is the internalization of hard information environment and consists of information consumption environment and the popularization and application of information technology. Based on the analysis of the above, informatization construction can enhance innovation capability through "carrot and stick".

B. Innovation Capability Index

There are many indexes to evaluate innovation capability, such as the increase of new high-tech product, the number of published journal, the number of patent application, the number of patent granted, the sales revenue of new products

and so on. This paper chooses innovation input capability and innovation output capability to evaluate innovation capability. In terms of innovation input, we choose R&D expenditure as the index of evaluating innovation input. R&D is the source of technological innovation. Every county spare no effort to increase research funds in order to strengthening science & technology and sustainable development capacity. Therefore, the investment of R&D expenditure can reflect the country's innovation activity intensity. In terms of innovation output, we choose the number of patent application as the index of evaluating innovation output. Compared with the number of patent granted, the number of patent application is little affected by patent agency's work efficiency and preference, so the number of patent application is a better index to evaluate innovation output capability.

C. Evaluation Index System

Combined with the analysis of informatization and innovation capability, as well as, based on the purpose of enhancing innovation capability and increasing social economy benefit, we construct the index system of informatization affects innovation capability(two variables, four secondary indexes, six third class indexes), as shown in "Table I".

TABLE I. Index system of informatization affects innovation capability

Variable	Secondary Index	Third Class Index	Explain of The Index
Informatization	hard information environment	The sate of informatization developmentX_1	The increased value of information industry accounts for the proportion of GDP
		The state of informatization human resource X_2	the number of information industry employees accounts for the proportion of employees in the whole society
	soft information environment	The state of information consumption X_3	Information consumption coefficient
		The popularization and application of information technology X_4	Internet users per million people
Innovation Capability	innovation input capability	the investment of R&D expenditure Y_1	R&D expenditure
	innovation output capability	The state of patent applicationY_2	The number of patent application

III. RESEARCH METHOD AND MODEL BUILDING

A. Research Method

Data Envelopment Analysis is proposed by American famous operations researchers A. Charnes and W. W. Cooper. It has been used in various industries and departments, and reflected excellent advantages in dealing with multiple input and output indicators. In recent years, DEA is a method which is widely applied in management evaluation .This paper mainly study the effect of the informatization on innovation capability. We choose some related informatization and innovation capability indexes to use DEA method, so explained variables are the efficiency value calculated by DEA and explaining variables are informatization and innovation capability indexes, then use multiple regression analysis and get rid of unreasonable variables, and so forth, until the whole system reach relatively stable.

Compared with other multi-objective evaluation methods, DEA has many advantages: when using DEA, we could not consider dimension, but other methods have to do so. And when using other evaluation methods, we should determine the relative weight of the indexes in advance and the function relation between input and output of decision making units, but DEA shouldn't. Therefore, the advantages of DEA is excluding many subjective factors and simplifying problems, that is, heightening objectivity of evaluating conclusions.

B. Model Building

Regression analysis generally refers to the calculation method or theory which is the correlation of one variable relative to other variables. It can calculate the overall average of the explained variable according to the given explaining variable.

The traditional multiple regression model:

$$lny=a+c_1lnx_1+c_2lnx_2+\ldots\ldots+c_nlnx_n \quad (1)$$

Thereinto,a is constant,y is explained variable,x_1、x_2、……、x_n are explaining variables,c_1、c_2、……、c_n are coefficients.

Optimizing the DEA variables, and we can view DEA efficiency value as explained variables and view informatization and innovation capability variables as explaining variables, building the model as shown below:

$$lnE=a+c_1lnx_1+c_2lnx_2+\ldots+c_nlnx_n+d_1lny_1+d_2lny_2+\ldots+d_nlny_n \quad (2)$$

thereinto, E is DEA efficiency value,x_1, x_2, ……, x_n are informatization variables,y_1, y_2, ……, y_n are innovation capability variables,c_1, c_2, ……, c_n and d_1, d_2, ……, d_n are coefficients, a is constant.

This paper's calculated thought is: first use DEA to calculate the efficiency, and then do regression analysis, so the method can be called a efficiency and regression model.

IV. MODEL CALCULATION

A. Data Selection

This article selected data form2009 to 2013,at the same time, considering the time lag that the effect of informatization on innovation capability, so when we doing the research ,we set the time lag for 3 years. The data comes from the yearbook of China Statistical and the yearbook of science and technology of China and CNNIC reports.

B. Model Calculation and Analysis

In this paper, the steps of applying model to calculate are: first use DEAP software to analyze the efficiency of each index data, then use the efficiency value as explained variable, using SPSS software for multiple regression analysis, finally come to the conclusion. Before efficiency and regression analysis, we should do descriptive statistical analysis. The result of descriptive statistical analysis is shown in "Table II", and the result of correlation analysis is shown in "Table III".

TABLE II.   DESCRIPTIVE STATISTICAL ANALYSIS

Variable	Secondary Index	Third Class Index	Minimum	Maximum	Average	Standard Deviation
Informatization	hard information environment	The sate of informatization developmentX_1	0.7930	0.9594	0.8855	0.0635
		The state of informatization human resource X_2	0.1655	0.3507	0.2663	0.0746
	Soft information environment	The state of information consumption X_3	3.1329	3.2288	3.1913	0.0375
		The popularization and application of information technology X_4	4.9200	6.1253	5.6080	0.4833
Innovation capability	innovation input capability	the investment of R&D expenditure Y_1	8.6660	9.3798	9.0435	0.2861
	innovation output capability	The state of patent applicationY_2	4.4746	5.3392	4.9179	0.3629

TABLE III.   CORRELATION ANALYSIS

		X_1	X_2	X_3	X_4	Y_1	Y_2
X_1	Pearson correlation	1	-0.643	-0.492	-0.594	0.636**	0.614**
	Significance (two-sided)		0.242	0.435	0.291	0.002	0.000
X_2	Pearson correlation	-0.643	1	-0.304	0.453	0.999**	0.993**
	Significance (two-sided)	0.242		0.619	0.221	0.000	0.001
X_3	Pearson correlation	-0.492	-0.304	1	-0.377	0.732**	0.598**
	Significance (two-sided)	0.435	0.619		0.531	0.005	0.000
X_4	Pearson correlation	-0.594	0.453	-0.377	1	0.643**	0.731**
	Significance (two-sided)	0.291	0.221	0.531		0.000	0.002
Y1	Pearson correlation	0.636**	0.999**	0.732**	0.643**	1	0.996**
	Significance (two-sided)	0.002	0.000	0.005	0.000		0.000
Y2	Pearson correlation	0.614**	0.993**	0.598**	0.731**	0.996**	1
	Significance (two-sided)	0.000	0.001	0.000	0.002	0.000	

First, we should input the data to DEA model, and do the efficiency analysis. Then, use the efficiency value as the explained variable to do multiple regression analysis. According to the result of regression, get rid of the failed indexes by t-test. Once again, do the efficiency analysis and regression analysis, and so forth, until all the indexes pass the test. Finally, we can come to the conclusion and summary the calculated result. As shown in "Table IV".

TABLE IV.   STATISTICAL MODEL CALCULATION RESULTS

Variable	Efficiency 1	Efficiency 2	Efficiency 3
Constant a	-0.6873** (-2.9342)	-0.7628** (-3.0946)	-1.3247** (-3.1134)
X_1	0.8261** (2.7979)	0.3265* (1.8775)	0.2364** (4.4750)
X_2	0.8203** (-1.7892)	0.9564** (-2.0312)	0.7894** (-2.3612)
X_3	0.4532* (2.7865)	0.8510* (1.0982)	0.7833** (1.4976)
X_4	0.1463 (0.3221)	——	——
Y_1	0.3285* (2.5568)	0.6435 (-0.3367)	——
Y_2	0.4931* (-1.4226)	0.4850* (2.3412)	0.6752* (2.4431)
R^2	0.7945	0.8324	0.8677

When doing the first efficiency and regression analysis, the three variables of the state of informatization development and informatization human resource and information consumption pass t-test in the percent of ten, but the index of popularization and application of information technology don't, so we should make further adjustment.

When doing the second efficiency and regression analysis, we should get rid of the variable of popularization and application of information technology and choose X_1-X_3 as informatization variables and choose Y_1-Y_2 as innovation capability variables and do the efficiency analysis. Then, view the calculated efficiency value as explained variables and plug the rest five variables into model 2 and then do the multiple regression analysis. The result of calculating is shown in "Table IV". As we can seen from the efficiency 2 line in "Table IV", its R^2 is 0.8324, so the model result is relatively stable. We can conclude that the state of informatization development and informatization human resource and information consumption and patent application pass t-test in the percent of ten, but the investment of R&D expenditure don't, so we should make further adjustment.

When doing the thrid efficiency and regression analysis, we should get rid of the variable of the investment of R&D expenditure and choose X_1-X_3 as informatization variables and choose Y_2 as innovation capability variable and do the efficiency analysis. Then, view the calculated efficiency value as explained variables and plug the rest four variables into model 2 and then do the multiple regression analysis.

The result of calculating is shown in "Table IV". As we can seen from the efficiency 3 line in "Table IV", its R^2 is 0.8677, so the model result is relatively stable. We can conclude that the state of informatization development and informatization human resource and information consumption and patent application pass t-test in the percent of ten, so we finish the model adjustment.

In this paper, we analyze the effect of informatization on innovation capability by using the efficiency and regression model, and the situation where R^2 is too small or efficiency is too low didn't appear. It is illustrate that the efficiency and regression model of the effect of informatization on innovation capability don't have structural errors, so the model is relatively stable.

V. CONCLUSION

According to the result of last chapter's efficiency and regression model, among the four informatization indexes, the sate of informatization development, informatization human resource and information consumption have obvious effect on innovation capability. However, the popularization and application of information technology hasn't obvious effect on innovation capability. The reason may be that the index's time lag may longer, but our research's time lag shorter and can't reflect its effect on innovation capability. And another reason is that the popularization and application of information technology only has significant effect on people's daily life, but hasn't widely effect in production development area.

On the basis of above analysis, we can draw the conclusion that informatization construction has significant effect on innovation capability. Therefore, both enterprises and country should attach importance to the informatization construction. Because informationization can enhance independent innovation capability, and then improve the ability of enterprise development and the national economic strength.

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