

# The Differences Analysis on R&D Efficiency Of Research Institutions and Universities

Lei Ming, Hou Baozhen, Gao Huiqing

Commercial college, Xi'an international university, Xi'an, 710077, China

**Keywords:** R&D efficiency, Data Envelopment Analysis; universities; research institutions

**Abstract.** There are many resources of technology innovation set in research institutions and universities; the research is based on data from science and technology activities of both research institutions and universities. It's achieved by using DEA analysis method with selecting relevant input and output indexes of both institutions. The paper analyzes the differences on R&D efficiency of both institutions and concludes that research institution's R&D efficiency is quite lower than the one of universities. The paper also dissects the reasons and gives out theoretical guidance that hopes to further improve the R&D efficiency of both institutions.

## 1 Introduction

It provides powerful technical support for industry development to research institution and universities, which is an important participant of innovation and the core force of bringing national development. There are a great deal of technological breakthrough owing to research institution and universities. It can drive the whole national development of innovation efficiency by promoting the R&D efficiency of research institution and universities. But, people pay more attention to the quantities of technology innovation than the innovation efficiency. The R&D efficiency is a tool to assess the contribution of personal, collectivity and whole science to the society. The R&D efficiency can reflect the development level of scientific research, whether the research funding is effectively invested in the activities of scientific research, whether scientists efficiently develop new products etc. R&D efficiency is the basis for evaluating work of scientific research. Improving the research and development efficiency of universities and research institution is an important part of the protection of China independent innovation strategy, it is a breakthrough in the construction of national innovation system. It is also the key to enhance China's capacity of independent innovation.

## 2 Structure the assessment indicator system

### 2.1 Select the assessment indicator

The assessment indicators about innovative input and output of research institution and universities are almost the same, which is R&D expenditure, instruments and equipment costs, manpower, the number of patents, number of papers, the number issues, the number of published scientific and technological works. Research institution and universities serve enterprise for the technological innovation. The key to enhance the innovation capability is to structure the assessment indicator system orientated to innovative quality and contribution. The paper select two input indexes: R&D personnel full-time equivalent, R&D expenditure and three output indexes: the number of scientific papers, number of published scientific and technological works, the number of request for authorized patents. That measures the R&D efficiency of research institution and universities. As shown in Table 1.

### 2.2 Evaluation method — Data Envelopment Analysis

Data Envelopment Analysis is to calculate the relative efficiency of the frontier through the linear modeling method to construct non-segmented surface, in order to evaluate the relative effectiveness of interdepartmental. DEA is a new method based on a set of input and output values to estimate the effective observation of production frontier.

input	output
R &D personnel full-time equivalent	the number of scientific papers number of published scientific and technological works
R&D expenditure	the number of request for authorized patents

Table1 the assessment indicator system of R&D efficiency

For each decision making units DMU<sub>j</sub> has a corresponding evaluation index of the efficiency

$$\max h_{j_0} = \frac{\sum_{r=1}^s u_r y_{rj_0}}{\sum_{i=1}^m v_i x_{ij_0}}$$

$$s.t. \frac{\sum_{r=1}^s u_r y_{rj}}{\sum_{i=1}^m v_i x_{ij}} \leq 1, j = 1, 2, \dots, n$$

$$u \geq 0, v \geq 0$$

To j<sub>0</sub>-target index, with all the efficiency of decision making units index for constraints, it constructs a CCR( C2R) models such as the following:

$$\max h_{j_0} = \frac{\sum_{r=1}^s u_r y_{rj_0}}{\sum_{i=1}^m v_i x_{ij_0}}$$

$$s.t. \frac{\sum_{r=1}^s u_r y_{rj}}{\sum_{i=1}^m v_i x_{ij}} \leq 1, j = 1, 2, \dots, n$$

$$u \geq 0, v \geq 0$$

This model is a fractional programming utilization Charnes-Cooper change order :

$$t = \frac{1}{v^T x_0} \Rightarrow w^T x_0 = 1 \quad t = \frac{1}{v^T x_0}, w = tv, \mu = tu$$

The optimal solution of linear programming is used to define the effectiveness of decision-making unit j<sub>0</sub>. In terms of evaluation of the effectiveness, DEA is absolute advantage in dealing with the multiple-input and multiple-output, which can avoid the impact of inconsistent elements of a unit of measurement and provide a fast and quantitative basis for evaluating the competitiveness of scientific research innovation.

### 2.3 Data Source

The source is from the arranged data based on the Statistical Yearbook China from 2006 to 2010, as shown in Table 2.

Index	Research institutions					Universities				
	2006	2007	2008	2009	2010	2006	2007	2008	2009	2010
R&D personnel FTE (ten thousand man-year)	23.1	25.5	26.0	27.7	29.3	24.2	25.4	26.6	27.5	29.0
R&D expenditure (billion Yuan)	56.73	68.79	81.13	99.60	118.64	27.68	31.47	39.02	46.82	59.73
the number of scientific papers	118211	126527	132072	138119	140818	830948	905985	964877	1016345	1062512
number of published scientific and technological works	3791	4134	4691	4788	3922	34633	35733	37541	40919	38101
the number of request for authorized patents	3499	4036	5048	6391	8698	12043	14111	19248	25570	37490

Table 2 Basic situation on technology activities of both research institutions and universities

### 3 Evaluate the R&D efficiency of research institutions and universities in China

#### 3.1 The input capacity of innovation resource

The input capacity of innovation resource is quantity and quality of sci-tech innovation resources, which mainly refers to the achievements conversion of independent innovation and the transformation capacity in science and technology innovation. In recent years, the government has increased the funds of science and technology in the research institutions and universities. The R&D expenditure of research institutions was 56.73 billion Yuan in 2006 that has been increased to 118.64 billion Yuan in 2010. The rate of growth was 21.26%, 17.94%, 22.77%, 19.12% from 2007 to 2010, average annual rate is up to about 20%. Meanwhile, the R&D expenditure of universities was 27.68 billion Yuan in 2006 that has increased to 59.73 billion Yuan in 2010. The rate of growth was 13.69%, 23.99%, 20%, 27.57%. The 5-year overall data shows the trends of growing R&D expenditure for each year. But government investment for universities R&D is only about 50% of the investment research institutions; universities still has the problem of resources shortage and supply shortage in different degree.

To a certain extent, the general funds of research and development match expenditures for the number of staff, and more staff should also cost expenditure. Another measure of the ability of innovation resources investment index is R&D personnel full-time equivalent character, even it is very close on number of participant staff for research institutes and universities, as is shown in Figure 1, the investment funds of universities are less than the one of R&D institution whereas the R&D personnel full-time equivalent, except in addition to 2009, are higher than the scientific research institutions, especially in 2006, the university scientific research project personnel are over research institution's more than 11,000 people, over more than nearly 5% , but the scientific research funds of the former is only 48.79% of the latter.

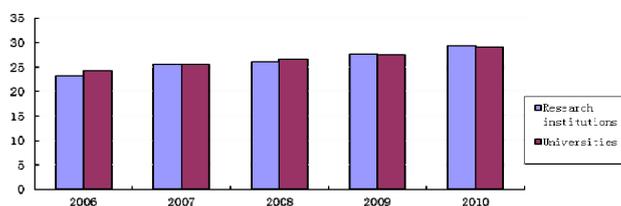


Figure 1 R&D personnel FTE

#### 3.2 The output capacity of innovation

In recent years, the output capacity of innovation and research is significantly enhanced in our country. Research institutions and universities published in scientific papers, publishing technology works, an application for a patent license number, etc. That all show more and more strong innovation output capacity momentum.

The number of scientific papers published research institutions were from 118200 in 2006 rose to 140800 in 2010, increased nearly 20% in the past four years. The number of published scientific and technological works increased respectively by 9.29%, 13.47% and 2.07% from 2006 to 2009. Although the number decline by 18.09% in 2010 than in 2009, but increased by 3.46% than in 2006. The number of request for authorized patents increased from 3499 in 2006 to 8698 in 2010, the rate of growth were 15.34%, 25.07%, 26.6%, 36.1%, average annual nearly 26%.

Meanwhile, the number of scientific papers in universities published from 830900 in 2006 rose to 1.0625 million in 2010 that is increased to nearly 28% in four years. The number of published scientific and technological works also presents a growth trend. The number of request for authorized patents increased from 12043 in 2006 to 37490 in 2010, the rate of growth were 17.17%, 36.4%, 32.84%, 46.62%, average annual growth of 33.3%.

Surveying data of the five years, the output capacity of innovation in universities were greatly higher than research institution. For example , to the number of request for authorized patents, the university is 244.18%, 249.63%, 281.3%, 300.1%, 331.02% of research institutions from 2006 to

2009(as shown in Figure 2), and universities has very obvious advantages as shown the absolute number.

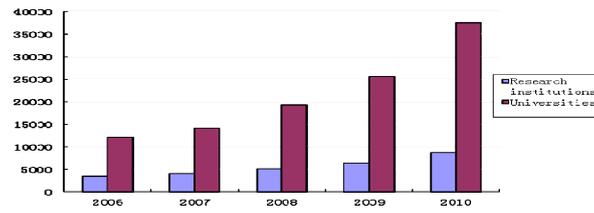


Figure 2 The number of request for authorized patents

### 3.3 Analyze comparison on R&D efficiency

By using data envelopment analysis (DEA) and application software of DEA Win4deap with measuring the data in Table 1, as the results shows that the R&D efficiency of research institutions is 0.304 and universities is 1 that is 3.29 times of research institutions, which indicates that universities' efficiency is higher than research institutions' in per capita contribution of scientific research personnel, in input and output rate of scientific research personnel, in the ratio of scientific research organization. On the whole, the scientific research strength of higher school is absolutely better than that of research institutions. The R&D efficiency of Universities is high-efficiency which attribute to many research institutions, to abundant resources of professional subject etc., that provide all-around and many fields for the scientific research in university.

## 4 Conclusions

In recent years, many universities in China gradually establish a management system of novel scientific research for adapting to the development of scientific research in building the process of research-oriented universities, and they enhance the efficiency of technological innovation by the ways of integration resources, increasing staff of professional scientific research, setting up independent platform of scientific research, building institution of science and technology etc. At the same time, the focus of a large number of outstanding talents in universities which bring to the height of the frontier technologies set. Researchers around the academic leader closely together aim to complete the task of scientific research which result that universities are gradually strengthened in general science and technology strength, the ability of independent innovation and comprehensive competitive power. The main status of technology innovation in enterprise have become increasingly prominent under the speed up the pace of innovation system construction in our country.it should be leading development of economic and social to science and technology. And some research institutions, especially the development class research institutions cannot be blended into the enterprise group, so that they are not able to play its scientific research innovation advantage and positioning enterprise innovation content and research topic key point that affects its innovation ability, which is very important reason is that, China's scientific research institutions is still lack of effective scientific research management system. Research institutions should actively reform research management mode, construct the innovation quality and contributions as the guidance of the performance evaluation mechanism, encourage and support scientific research personnel convert scientific research achievements into productive forces, and improve the ability of independent innovation.

## References

- [1]Fang Xiuwen ,Gong Jianwen etc.Research on the main problems and policy of scientific and technical innovation in Guang dong. Study on the management of science and technology [J]. December 2008, pp.182-184.
- [2]Zhang Shaoying. Rearch on the influence of System of scientific research management at universities and R&D efficiency [J]. China's economic and trade. October 2009 ,pp.169-170.

[3] Meng Wei, Zhang Daqun, Liu Wenbin. Multi-level structure model and its application[J].Chinese journal of management science. August 2008 pp.148-153.