Empirical Analysis on the Correlation of Patent Applications with R&D Input

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ABSTRACT

Patent applications is an important index to measure a country's scientific and technological level, also reflects the scientific research output efficiency of key indicators. Patent applications and research inputs should in theory are closely related. Based on the Cobb-Douglas production function, this study takes the patent applications and R&D input into the model. It uses the data of patent applications, R&D staff and R&D capital expenditure investment in China from 1995 to 2014. The study finds that patent application is closely related to the R&D staff and R&D capital investment. The result shows that the elasticity of R&D capital input is higher than that of R&D staff input in patent input-output model. It also discovers that the characteristic of procedure of patent input-output is increasing returns to scale.

Keywords: patent application; R&D capital investment; R&D staff inputs; regression analysis

1 INTRODUCTION

Patent, a kind of intellectual property, is the world's largest source of scientific and technical information. According to the relevant statistics, patents take up 90%-95% scientific and technical information in the world. Patent application and authorization is an important index for measuring a country's scientific research output, as well as a number of countries with independent intellectual property rights is an important symbol of a country's level of technological development. The studies of main impact of patent applications and quantitative relations between each other are very important.

Starting from 2011, China has become NO.1 of the world's patent application. In 2015, China invention patent applications exceeded 1 million for the first time, for 5 consecutive years ranked first in the world. Under the guidance of the national innovation strategy, the 2014 National Science funding Bulletin of statistics data show...
in 2014, total R&D funding 1,301,560,000,000, so R&D 2.05% was first breakthroughs in investment intensity, while the total amount of R&D investment in China in 2012 has ranked third in the world.

As an important index of research output of patent applications and as a measure of scientific research level R&D total funding, both ranking in the world, both the existence of a relevant degree and become the main content of this study.

2 REVIEWS

Experience from sense, the large investment the larger higher probability of return. Increased R&D the investment to improve patent applications become common, many scholars have also conducted in-depth research from different perspectives. Sun & Tang (2003) by patent applications and quantitative study of the relationship between R&D expenditure conclusion: scientific research institutions and universities, and the patent application and R&D spending there is no correlation between business R&D spending will have a significant impact on the patent applications[1]. Zhu & Fang (2007) analysis of different categories of countries R&D funding relationship with the patent application, analysis found that research and development power of patent applications and there is significant positive linear relationship between R&D expenditure, weak research and development of patent applications between R&D expenditure and there is a significant quadratic or cubic function[2].

Although the researcher or patent application different from institution angle or from an empirical analysis of spending on different national perspectives, but their models in empirical research of regression analysis does not fully take into account the linear regression of the main precondition that is testing for serially uncorrelated, heteroscedasticity and no multicollinearity, or prone to "spurious regression" or errors of parameter estimation significant And R&D inputs also have a delay effect is also not covered.

3 METHODOLOGY

We mainly use the linear regression method and model impact assessment theory, to study China's patent applications and R&D capital expenditures, R&D staff relationships between inputs. Based on the quantitative and data-acquisition, such as considerations such as assets, lagging behind other factors into account such as. To this end, the paper puts forward the following two assumptions, and after to modeling and verification.

Hypothesis 1: patent applications and R&D funds are related;
Hypothesis 2: patent applications and R&D staffs are related.

Think in terms of data availability, dependent variable is patent applications; explanatory variable are expenditure within the R&D and R&D personnel full-time equivalents. Selection is based on support for science and technology in China mainly relies on funding and personnel input. Based on the above, China's patent application
effects of factor inputs, namely, capital and labour. Specific patent applications in China mainly relies on scientific research institutions, universities and large and medium enterprises. China mainly relies on the three R&D internal funding support. And technology workforce in China's major scientific research institutions, enterprises, universities, researchers, R&D personnel full-time equivalents reflect the input of R&D human scale and intensity. R&D staff R&D personnel including enterprises, scientific research institutes, institutions of higher learning and is a community of innovation R&D total human input. R&D personnel full-time equivalents are calculated according to the amount equivalent to the R&D staff.

The study on relationship between for R&D input and patents output, and generally use two methods: method of parametric and non-parametric. Parameter method used classical Cobb-Douglas production theory and quantitative analysis and nonparametric method using DEA (DEA) modeling and analysis. Nonparametric method but lack of effective description of the production process, this study will use the classical theory to modeling. In the Cobb-Douglas production function model of variable and the explanatory variable is the relationship between inputs and outputs, specific form:

\[
\ln Z_{SQL} = C + \alpha \ln RDC + \beta \ln RDL + \varepsilon 
\]

\( Z_{SQL} \): patent applications;
\( RDC \): R&D internal expenditure of funds;
\( RDL \): R&D full-time equivalent personnel;
\( C \): constant terms;
\( \varepsilon \): Random error;

\( \alpha \), \( \beta \): Represent expenditures within the R&D elasticity, elasticity of R&D personnel full-time equivalents.

This study uses data from 1995-2014 of the China Science and Technology Statistics Yearbook, time series for 20 years, patents of which production inputs capital expenditure data within the R&D; patent production inputs use R&D personnel full-time equivalents human data; patent output use patent applications.

4 Regression analysis
According to the model (1), using least squares regression estimates, the statistics are as shown in Figure 1.
In Figure 1, we can see that the r-squared value is equal to 0.998 and adjustment equal to 0.998, fitting very well and t are notable, and preliminary observation variables there is no collinearity. And the sample test results equal to 1.6 DW values, check table DW test critical values DU=1.535, DU<1.6<4-DU, sample of no autocorrelation. White test as shown in Figure 2. We can see from Figure 2, p values were significantly greater than 0.05, so the sample is not present heteroscedasticity.

According to the preliminary results of regression analysis, and final form of the equation is:

\[ \ln Z_{LSQ} = -3.56 + 0.64 \ln RDC + 0.75 \ln RDL \]  

(2)

5 CONCLUSIONS

According to the model (2), when \( \alpha = 0.64, \beta = 0.75 \):

(1)As \( 0 \leq \alpha \leq 1 \), we accept assumption 1, which patent application of positive correlation with R&D capital investment. And R&D investment and patent output elasticity is 0.64, meaning that officers put under constant conditions, funding for each 1%, patent 0.64%.

(2)As \( 0 \leq \beta \leq 1 \), we accept hypothesis 2, namely patent applications with R&D staff put a positive correlation. And R&D staff input and patent output elasticity is 0.75, which means that funding under the condition of constant, staff input for each 1%, patent 0.75%.
(3) As \( \alpha + \beta = 0.64 + 0.75 = 1.39 > 1 \), patent output is increasing returns to scale, that is in the course of patent output, if all of the inputs (money, people) increased 1 time, then the patent output increased by more than 1 time.

(4) As \( \alpha < \beta \), input-output description in the patent process, R&D funding is less than R&D staff input, thus personnel input elasticity than the flexibility of funding.

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