STUDY ON THE IMPACT OF GOVERNMENT SCIENCE AND TECHNOLOGY INNOVATION SUBSIDIES ON ENTERPRISE TECHNOLOGICAL INNOVATIVE ABILITY BASED ON THE PERSPECTIVE OF INTERNAL CONTROL

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Abstract

In the context where Chinese government has been constantly increasing science and technology innovation subsidies but only made few achievements, the factors affecting the effect of science and technology innovation subsidies from the government have become hot issues. Taking high-tech listed companies between 2013 and 2016 as samples and applying the data envelopment analysis (DEA) method, this paper launches studies on R&D input and output of enterprises, so as to measure their innovative ability. As indicated in the empirical results, government science and technology innovation subsidies have lifted enterprise innovative ability, and further studies have shown that internal control is positively regulating the impact of government science and technology innovation subsidies on enterprise innovative ability. The study not only proves the positive impact of government science and technology innovation subsidies on enterprise innovative ability, but also figures out one way for China to further improve the effect of government science and technology innovation subsidies, which is government science and technology innovation subsidies shall be granted to the enterprises with highly effective internal control.

Keywords: internal control, government science and technology innovation subsidies, enterprise innovative ability, data envelopment analysis (DEA)

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Introduction

It is hard to improve enterprise technological innovative ability and level merely by those enterprises. Therefore, it is necessary for the government to provide intervention and incentives, so as to promote improvement of enterprise innovative ability. In recent years, Chinese government has been constantly increasing science and technology innovation subsidies to innovative enterprises. However, there are problems like some subsidies have been used for other purposes, enterprise technological innovative ability has not been obviously improved, and few achievements have been made. As an important management mechanism for enterprises, internal control can enhance enterprise management performance. Nevertheless, researches concerning whether or not internal control can positively regulate the impact of government science and technology innovation subsidies on enterprise innovative ability have important theoretical and practice significance.

Research Objectives

The study on whether internal control can positively regulate the use effect of government science and technology innovation subsidies to improve enterprise technological innovative ability is of great theoretical and practical significance.

First of all, the study on whether the effect of government science and technology innovation can be positively regulated by internal control is of great theoretical important, as there are few research had been done on this area. This paper could fill the gap of correlated academic field.

Second, if the enterprise technological innovation ability could be improved by internal control is of practical significance. Only by knowing the true effect of if technological innovation ability improved or not, can the government decide to subsidies more or less.

Literature Review

(I) Review of Study on Government Science and Technology Innovation Subsidies and Enterprise Technological Innovative Ability

Currently, there are mainly two viewpoints in the academic field. From one point of view, government science and technology innovation subsidies have the “encourage effect”. From existed relevant literature, the methods to measure enterprise innovative ability can be divided into two categories. For the first category in most literature of early stage, the R&D input index is chosen to measure the enterprise innovative ability. As indicated from the study carried out by Hamberg (1966), the government subsidies provided by Department of Defense of United States have positive impact on enterprise innovative input Li, Ye & Wang (2013) indicate that government subsidies not only can promote increase of enterprise R&D input, but also can increase enterprise self-financing technological innovative input. For the second category, the R&D output is chosen as a measurement variable of enterprise innovation. As suggested from the study carried out by

Nola (2009), government science and technology subsidies have lifted enterprise ability in new product improvement and development. Studies have shown that government subsidies have obviously positive impact on the innovative output of large and medium-sized industrial enterprises Chen & Zhao (2008), Bai & Li (2013).

From the other point of view, government science and technology innovation subsidies have the "crowding-out effect". As indicated from the study carried out by Xiao & Lin (2014), some government science and technology innovation subsidies have been used in excessive investment and raising executive compensation, and have not increased enterprise economic profit or improved enterprise innovative ability; moreover, most enterprises are still in the field of low technology and low additional value, and have low innovative efficiency. Through applying the game theory, Gao (2011) has proved that excessive government subsidies and the current subsidy structure will reduce the R&D input of large-sized state-owned enterprises, and will not promote improvement of enterprise innovative ability. Study of Xu, He & Wang (2012) stated that government subsidies will promote enterprise to increase science and technology innovation input, but excessive government subsidies are not conducive to improve enterprise technological innovative ability.

(II) Review of Study on Internal Control and the Effect of Government Subsidies

Internal control has always been the focus of researches, because the five factors of internal control are closely related to the effect of government subsidies. In recent years, people have gradually paid attention to the impact of internal control on the use effect of government subsidies. Zheng (2014) put forward that internal control can settle relevant problems inside an enterprise in respect of property rights, information inconsistency and input-output efficiency. Solving such problems can help to improve the effect of government subsidies. In addition, as indicated by empirical analysis, the ownership structure, market level and political relevance are all important factors influencing their relationship. Lv (2011) thought that the failure of government subsidies to achieve their intended purpose is closely related with insufficient implementation of internal control of enterprises; as proved by empirical results, enterprises with good internal control can better help realize the goal of government subsidies. It is suggested that enterprises establish complete enterprise internal control in accordance with their actual situations.

It can be seen from literature review that scholars remain controversial opinions on the impact of government science and technology subsidies on enterprise technological innovation, mainly because of the differences in the measuring methods of enterprise technological innovation and industry option. Based on scholars' previous researches, taking hi-tech enterprises as study objects and applying the data envelopment analysis method, this paper conducts comprehensive measurement on enterprise technological innovation ability, and

further summarizes and explores their relationship, which is of certain theoretical value. Both domestic and foreign scholars have studied on the impact of government science and technology subsidies on enterprise technological innovation and studies on the impact of internal control on the effect of government subsidies. However, few scholars have studied the impact of internal control and government science and technology innovation subsidies on enterprise technological innovation by taking internal control as a regulating variable.

Theoretical Analysis and Research Hypothesis

Government science and technology innovation subsidies can directly provide enterprises with sufficient fund support. An, Zhou & Pi (2008) proposed that government science and technology innovation subsidies can reduce the R&D cost of an enterprise, increase unit product profit of an enterprise, so as to benefit the enterprise and finally achieve the effect that the enterprise attaches importance to improving its innovative ability. Weisberg (1996) put forward that there is a process for an enterprise from innovation input to harvest the innovation achievements, the improvement of enterprise innovative ability cannot be immediately shown and generally will lag one or two years. On this basis, the Thesis proposes the hypotheses as follows:

H1: In the condition of absence of constraint, government science and technology innovation subsidies have promoting effect on enterprise innovative ability, and such promoting effect will have some lag.

Viewed from the theory of property rights, internal control can effectively prevent an enterprise from seizing the property rights in the public field, so as to guarantee the safety and integrity of government science and technology innovation subsidies. Viewed from information delivery, internal control can guarantee enterprises to make reasonable use of government science and technology innovation subsidies, so as to make subsidies play a positive role in improving enterprise innovative ability. Effective internal control can make enterprise operation and management highly apparent and open, make enterprises consciously use government science and technology innovation subsidies in accordance with the specified purpose, and improve enterprise innovative ability. Based on the above theoretical analysis, this Thesis further studies the impact of government science and technology innovation subsidies on enterprise innovative ability under the constraint of the effectiveness of internal control, and proposes the following hypothesis:

H2: Under the constraint of the effectiveness of internal control, the positive correlation between government science and technology innovation subsidies and enterprise innovative ability enhances.

Study Design

(I) Data Source and Sample Selection

This Thesis takes the data from China's high-tech listed companies between 2013 and

2016 as samples. Data of internal control are from DIB database, data of enterprise technological innovation input and output are from WIND database, relevant data of government science and technology subsidies are from enterprise annual reports, and other variable data are from CSMAR database. During sample selection for this Thesis, the following three points will be considered: firstly, ST or ST* companies will be removed; secondly, companies with 0 patent application and R&D input will be removed, because DEA model requires the input-output value over 0; thirdly, companies with incomplete data will be removed. Ultimately, 264 sample observed values are acquired, 67 of which are in 2013, 67 in 2014, 71 in 2015 and 59 in 2016. During the study, software like DEAP, Excel and SPSS.19.0 has been applied.

(II) Definition of Variables

Interpreted variable: enterprise innovative ability (RDE). Enterprise innovative ability is the enterprises' ability measured from the complete relevant activities in respect of innovation. The following three points have been taken into account when the index is selected: firstly, the DEA method proposed by Charnes, Cooper & Rhodes (1978) is adopted to measure enterprise innovative ability, which is suitable to evaluate the efficiency of companies with high investment and output. Secondly, technological innovation is generally inspected from the two aspects of technological innovation input and output. R&D input is considered from fund input and personnel input. In this paper, with the indexes used by Shi & Lu (2010), fund input is measured with the R&D cost; personnel input is measured with the number of technicians in the company; and R&D output is measured with the number of patent application adopted from Huang (2016). Thirdly, when considering the lag length, this paper selects the lag length of R&D activities as one year, that is enterprise performance in year t of enterprise's science and technology innovation input in RDE activities in year t-1 shall be regarded as the output effect. In addition, the DEA model is employed to calculate the R&D investment efficiency of an enterprise (RDE).

Interpreting variable: government science and technology innovation subsidies (Gov). Since there are many enterprise subsidy projects granted by the government, including direct subsidy projects and indirect subsidy projects, this paper selects direct subsidy projects related with enterprise technological innovation projects, such as projects in terms of special funds for scientific development, scientific innovation funds, patented technology support funds and enterprise technology innovation etc. Appling the python software to write a program to acquire relevant data from income details other than the financial statements of listed companies, this paper summarizes data of these projects, and finally obtains the variable data of government science and technology subsidies.

Regulating variable: internal control index (ICI). The internal control index reflects listed companies' risk control ability. Higher index reflects stronger risk control ability of a company. In this paper, most scholars' methods

(Yang, Lin & Wang, 2009; Zhao & Zhang, 2013) are adopted, and the internal control index of DIB listed company in China on the China Internal Control and Risk Management Network is selected.

Control variable: in accordance with research literature on enterprise innovation, the capital structure (asset-liability ratio = total liabilities / total assets), market competitiveness (ratio between sales expense and operating revenue), profitability (return on assets ROA), enterprise size (total assets of an enterprise at the end of one year) and equity structure (the largest shareholder's share ratio) are selected as control variables. Meanwhile, time virtual variables are controlled.

$$RDE_{i,t} = \alpha_0 + \alpha_1 GOV1_{i,t-1} + \alpha_2 GOV1{*}CIC1_{i,t-1} + \sum \lambda Var_{i,t-1}^{con} + \varepsilon_{i,t-1}$$

In the above formula, $RDE_{i,t}$ refers to the innovative ability of Company i in the t period, $GOV1_{i,t-1}$ refers to the government science and technology subsidies of Company i in the t-1 period, $GOV1 * CIC1_{i,t-1}$ refers to the cross variable of science and technology innovation subsidies and internal control after data centralization of Company i in the t-1 period, and $Var_{i,t-1}^{con}$ refers to the control variable of Company i in the t-1 period.

Empirical Study

(I) Descriptive Statistics

Descriptive statistics results of the samples may refer to Table 1.

Table 1 includes 265 sample data of China's Shanghai and Shenzhen A share market during 2013-2016. As indicated in the descriptive statistics of all variables, the enterprise innovative ability (RDE) calculated with the DEA model is relative efficiency, with the value scope ranging from 0 to 1, the average value to be 0.1411 and median value 0.0657, reflecting that the R&D investment efficiency of China's hi-tech enterprises is not high and the R&D investment efficiency of over a half of them is below 0.0657. The average value of government science and technology innovation subsidies is 7651 683.0247, with the median value to be 1 847 751. Viewed from the minimum value, maximum value and standard deviation, there are large differences between government science and technology

(III) Model Specification

In this Thesis, the following study model is built to verify the preceding study hypotheses.

H1: In the condition of absence of constraint, government science and technology innovation subsidies have promoting effect on enterprise innovative ability, and such promoting effect will have some lag.

$$RDE_{i,t} = \alpha_0 + \alpha_1 GOV_{i,t-1} + \sum \lambda Var_{i,t-1}^{con} + \varepsilon_{i,t-1}$$

H2: Under the constraint of the effectiveness of internal control, the positive correlation between government science and technology innovation subsidies and enterprise innovative ability enhances.

innovation subsidies of China's enterprises. However, viewed from the nature logarithmic (Gov(LN)), the standard deviation drops and is 1.9118. The average value of internal control index is 676.8123, which is close to the median value. Viewed from the minimum value, maximum value and standard deviation, it reflects that there exist obvious differences between the internal control levels of sample companies. Nevertheless, when viewed from the nature logarithmic (ICI(LN)), the standard deviation drops and is only 0.1173. Among the control variable results, viewed from the extreme values and standard deviation of asset-liability ratio (LEV), return on equity (ROE), market competitiveness (MAR), equity structure (Share) and enterprise size (size), there exist certain differences between sample companies, the difference of enterprise size is the biggest and the difference of return on equity is the second biggest. The average value, minimum value and maximum value of market competitiveness (MAR) are 0.0892, 0.0029 and 0.4580 respectively, reflecting that the difference of the ratio between sale expense and operating revenue of sample companies is relatively big, and the difference of some companies is even up to 46%. Viewed from the whole range and standard deviation, the value span of variables is large while the dispersion degree is relatively small, which fully reflects the difference between samples on variables, and has good statistics features.

Table 1 Descriptive Statistics Results of Variables

Variables	Whole Range	Minimum Value	Maximum Value	Average Value	Median Value	Standard Deviation
RDE	0.9990	0.0010	1.0000	0.1411	0.0657	00.2037
ICI	531.2000	379.2300	910.4300	677.8133	689.9600	68.3198
ICI (LN)	0.8758	5.9381	6.8139	6.5118	6.5366	0.1173
Gov	232 446 306.3	1 500	232 447 806.3	7650 683.0341	1 847 650	24 816 464.8076
Gov (LN)	11.9510	7.3132	19.2642	14.2521	14.4281	1.9014
LEV	1.0010	0.0351	1.0361	0.3857	0.3783	0.1890
ROE	0.9311	-0.3116	0.6195	0.0871	0.0757	0.0928
MAR	0.4550	0.0029	0.4580	0.0892	0.0551	0.0787
Share	0.6295	0.0680	0.6975	0.3338	0.3026	0.1401
Size	5.7463	19.6300	25.3763	21.8141	21.7099	1.0383
Effective N	264					

(II) Correlation Analysis

Correlation analysis results of variables may refer to Table 2

Table 2 Correlation Analysis Results of Variables

Variables	ICI (LN)	GOV (LN)	RDE	LEV	ROE	MAR	Share	Size
ICI(LN)	1							
GOV(LN)	0.150** (0.015)	1						
RDE	0.065 (0.291)	0.111* (0.072)	1					
LEV	-0.219*** (0.000)	0.060** (0.333)	-0.008 (0.896)	1				
ROE	0.524*** (0.000)	0.147** (0.017)	0.067* (0.097)	-0.057 (0.358)	1			
MAR	0.142** (0.021)	0.223*** (0.000)	0.079* (0.083)	-0.257*** (0.000)	0.102* (0.097)	1		
Share	0.145** (0.018)	-0.066 (0.284)	0.086* (0.062)	0.074 (0.231)	0.212*** (0.001)	0.085 (0.169)	1	
Size	0.063 (0.307)	0.275*** (0.000)	0.022 (0.723)	0.592** (0.000)	0.185** (0.002)	-0.159** (0.010)	0.248*** (0.000)	1

Notes: *, ** and *** refer to significant correlation under the (bilateral) level of 10%, 5% and 1% respectively (same in the below table).

The correlation between indexes may be comprehended from Table 2. As indicated in the table, government science and technology innovation subsidies (Gov (LN)) has positive correlation with enterprise innovative ability (RDE), with the correlation coefficient to be 0.111. In addition, they will be significantly correlated under the level of 10%. It indicates that government science and technology subsidies may help improve the enterprise future innovative ability. In other words, the higher government science and technology innovation subsidies are, the higher the enterprise innovative ability is. In order to verify H1, regression analysis verification will be conducted below. In terms of control variables, data in the table indicate that return on equity (ROE), market competitiveness (MAR) and the largest shareholder's

share ratio (Share) have significant correlation with enterprise technological innovation efficiency under the level of 10%, which is consistent with scholars' previous research achievements. The asset-liability ratio (LEV) has negative correlation with enterprise innovative ability, while the enterprise size (Size) has positive correlation with enterprise innovative ability, which is consistent with the logic. The insignificant results may be possibly caused by the data selected from different industry.

(III) Regression Analysis

In order to verify the lag issue concerning the promoting effect of government science and technology innovation subsidies on enterprise innovative ability, regression analysis and comparison are conducted on the enterprise innovative ability of one lag period and the enterprise innovative ability of the current period, and the results may refer to Table 3. Government science and technology innovation subsidies (Gov(LN)) have significant correlation with and enterprise innovative ability (RDE) of one lag period under the level of 5%, and have insignificant correlation with enterprise innovative ability of the current period, which has verified H1. Due to the lag issue, enterprise innovative ability cannot present significant promoting effect immediately. The more science and technology subsidies that the government provides to enterprise, the more conducive they are to improve enterprise future innovative ability.

Table 3 Regression Analysis Results of Studied Variables

Variables	Enterprise Innovative Ability of One Lag Period		Enterprise Innovative Ability of the Current Period	
	T	Sig.	T	Sig.
GOV(LN)	1.655**	0.041	0.308	0.759
LEV	-0.186	0.852	-2.671	0.898
ROE	0.544*	0.087	3.184*	0.082
MAR	0.584*	0.060	0.888	0.375
Share	1.387*	0.067	0.666	0.506
Size	0.481	0.631	1.079	0.282
R-squared	0.125		0.105	
Effective N	264			

Table 4 Regression Analysis Results of Studied Variables

Variables	RDE	
	Coefficient	Sig.
Gov1	1.747*	0.082
Gov1*ICIl	3.101***	0.002
LEV	0.056	0.956
ROE	0.684	0.495
MAR	1.085*	0.079
Share	1.064*	0.088
Size	0.060	0.952
Effective N	264	
R-squared	0.115	

Before verifying the regulating effect of internal control on the relationship between government science and technology innovation subsidies and enterprise innovative ability, in order to reduce the multi-collinearity between the interaction item and the interpreting variable or the regulating variable, this Thesis firstly centralizes government technological innovation subsidies (Gov(LN)) and internal control (ICI(LN)), to get Gov1 and ICI1 respectively. Following, the cross variable Gov1*ICI1 is obtained, with the result shown in Table 4. The centralized government science and technology innovation subsidies (Gov1) and enterprise innovative ability have significant correlation under the level of 10%, and the cross item (Gov1*ICI1) is significantly correlated with enterprise innovative ability under the level of 1%, which has verified H2. Under the constraint of the effectiveness of internal control, the positive correlation between government science and technology innovation subsidies and enterprise innovative ability enhances. In other words, internal control has the regulating effect on the relationship between government subsidies and technological innovative efficiency.

(IV) Robustness Test

In order to verify the robustness of results, by referring to the median grouping method proposed by Li & Yang (2013), Su & Luo (2016), internal control level is divided into the high quality group and the low quality group according to the median value 690, and then regression analysis is carried out respectively. As shown in Table 5, the standard deviation 1.8831 of government science and technology innovation subsidies for the high quality internal control group is higher than that of the low quality internal control group 1.8301, proving that government science and technology innovation subsidies of enterprises with high quality internal control are generally higher than that of enterprises with low quality internal control. Government subsidies of the high quality internal control group are significantly correlated with enterprise innovative ability under the level of 1%, while government subsidies of the low quality internal control group are insignificantly correlated with enterprise innovative ability, which also proves that internal control quality of an enterprise influences the relationship between government science and technology innovation subsidies and enterprise innovative ability.

Conclusions and Suggestions

This Thesis studies the relationship between internal control, government science and technology innovation subsidies and enterprise innovative ability, and mainly comes to the conclusions as follows: (1) government science and technology innovation subsidies have promoting effect on enterprise innovative ability, and the promoting effect is lagging to some extent; namely, the more government science and technology innovation subsidies are, the stronger enterprise innovative ability is. (2) Internal control effectively restricts misuse of funds, and increases the use efficiency of government science and technology innovation subsidies; under the constraint of the effectiveness of internal control, the positive correlation between government science and technology innovation subsidies and enterprise innovative ability enhances.

Through theoretical analysis and empirical study, this Thesis comes to the conclusion that effective internal control can positively regulate the promoting effect of government science and technology innovation subsidies on enterprise innovative ability, which is of certain reference significance to the supervision authorities and enterprises in China. (1) Supervision authorities shall attach importance to publishing relevant information on internal control of listed companies, specify the reporting contents of internal control, supervise use of listed companies' government subsidies, improve information on internal control of enterprises to be disclosed to public, and through legislation punish persons who misuse subsidies and use subsidies not in accordance with provisions, so as to finally realize the goal of improving the use efficiency of government subsidies. (2) Enterprises shall also pay attention to the function of internal control on the use effect of government science and technology innovation subsidies, improve enterprise internal control rules, put government science and technology innovation subsidies into practical use, and give full play to the promoting effect of government science and technology innovation subsidies on enterprise innovative ability. In addition, strengthening enterprise internal control can also find a solution to reducing management's appropriating subsidies.

Owing to the researchers' ability, time and capital shortage, the limited samples selected might result in the incompleteness of this study. This is merely a pilot study worth deeper research. At first, variables tested have limitations because all of the scales used are developed for general companies not the high-tech ones. Furthermore, samples are within the confines of listed companies, which would cause deviation of the results.

Table 5 Regression Analysis Results of Studied Variables

Variables	High Quality Internal Control Group		T Test		Low Quality Internal Control Group		T Test	
	Average Value	Standard Deviation	T	Sig.	Average Value	Standard Deviation	T	Sig.
GOV (LN)	14.684	1.8831	2.827**	0.005	13.820	1.8301	0.659	0.511
LEV	0.3593	0.1744	-1.427*	0.086	0.4120	0.1997	0.975	0.331
ROE	0.1189	0.0825	1.673*	0.097	0.0553	0.0920	0.646	0.520
MAR	0.0992	0.0844	0.032	0.975	0.0770	0 0712	0 327	0 744
Share	0.3409	0.1453	1.729*	0.086	0.3267	0.1348	0.063	0.949
Size	21.8165	1.0933	0.258	0.797	21.8116	0.9845	-0.210	0.834

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