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Can Government Subsidies Promote Corporate R&D Investment ? Evidence from China

Jinlan Yang
School of Business, Jiangsu University of Technology, Changzhou, China
Email address: 1134204857@qq.com

Abstract— *This paper investigates the relationship between government subsidies and R&D investment. With a sample of Chinese listed companies in Shanghai and Shenzhen A-shares from 2010 to 2019, the results show that government subsidies have a long-lasting sustained positive impact on corporate R&D investments, and the cumulative effect of R&D results is significant; Therefore, paying attention to the relationship between government subsidies and enterprise R&D investment Provide more references for government policy making and enterprise innovation development.*

Keywords— *Government Subsidies; R&D Investment.*

I. INTRODUCTION

Innovation is the first driving force of high-quality development. However, technological innovation in most Chinese enterprises is still at a relatively rudimentary stage. The characteristics of innovation activities predestine most enterprises to be fearful in carrying out innovation activities. Therefore, it is particularly important for the government to play a macro-control role to help enterprises get out of the development dilemma and achieve the common development of themselves and society. Our government has been vigorously strengthening subsidies in various aspects. Therefore, it is necessary to understand whether government subsidies are a "strong shot" or a "talisman" for enterprises struggling to survive on the road to innovation. At the same time, studying the effects of government subsidies and observing the advantages and problems of the current subsidy policy can also guide the government to review the effectiveness of the policy and make the next policy adjustments.

II. HYPOTHESIS DEVELOPMENT

Government subsidies can directly reduce the R&D cost and R&D risk effect of enterprises (Xu, J. et al. 2021), indirectly help enterprises to expand financing, compensate for losses (Zhu, Z. et al. 2019), increase R&D investment, reduce the negative impact of the "crowding-out effect" brought by the fulfillment of social responsibility and other expenses (Dobrzanski P. et al. 2020), and prevent the negative impact on enterprises caused by the breakage of the capital chain due to R&D failure(Wu, T. et al. 2020). At the same time, government subsidies can signal to the market and indirectly prove the promising prospect of their own R&D projects (Zhang, H. et al. 2019), lower the threshold effect of the enterprise's R&D in science and technology, and accordingly, the marginal utilization rate of the government subsidies will be more significant when the enterprise uses them. According to neoclassical technology innovation theory (Auerswald, P. et al. 2000), the externalities exhibited by R&D investment will lead to market failure, while government subsidies can compensate part of the external losses of enterprises, boost their R&D confidence and form a good competitive situation for innovation. (Xie, Y et al. 2022)

In summary, this paper proposes the following hypothesis: Hypothesis 1: Government subsidies have a positive contribution to enterprise R&D investment, i.e., government subsidies are positively related to enterprise R&D investment.

III. MATERIALS AND METHODS

Sample and data

The sample collected from the China Stock Market and Accounting Research (CSMAR) database and the Wind database, initially comprises all firms listed on the Shanghai Stock Exchange and Shenzhen Stock Exchange. This paper selects the period from 2010 to 2019 as the window period.

Companies with the following conditions are excluded: 1. which is ST or ST*; 2. those do not disclose R&D investment and government subsidies;3. those with asset-liability ratio >1; 4. financial industry, financial service industry and other financial industries; 5. those with too many missing values in annual report disclosure data are excluded, and finally 3012 companies in 76 industries were selected as experimental data, and the data were processed using Stata 16.0.All continuous variables are winterized by 1%.

Main variables

The technological R&D of enterprises is closely related to the amount of R&D funds invested, and the amount of R&D investment is the most intuitive way to reflect the R&D capability and R&D enthusiasm of enterprises. In order to avoid the influence of large differences in R&D levels of different companies in different industries, this paper adopts the natural logarithm of enterprise R&D investment as an indicator of R&D investment intensity by referring to relevant studies of some scholars.

Government subsidies in China include funds, financial assistance, low-interest loans, etc. This paper aims to explore the influence of direct government subsidies on R&D innovation capacity and enthusiasm, so the amount of subsidies by indirect means such as tax incentives is not counted and studied. Considering the large differences among data, this

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paper refers to the practice of authoritative scholars and uses the natural logarithm of government subsidy amount to measure the intensity of government subsidies.

In this paper, with reference to relevant studies, we select the company's age, financial leverage (FL), earnings per share (EPS), equity concentration (OC), board size (BBS), and return on assets (ROA) as control variables. The relevant variables and their measurement are summarized in Table 1.

TABLE 1. Definition of variables

Name of Variables	Description of Variables
Research input	Natural logarithm of R & D investment
Public subsidy	Natural logarithm of government subsidies
Social responsibility	Hexun Social Responsibility Score
Company established years	Company age
financial leverage	Total liabilities / total assets
earnings per share	Net profit / total number of shares
Equity concentration	Number of shares held / total shares of the largest shareholder
Board size	Total number of board members
return on assets	Net profit / average total assets
Annual dumb variable	Year virtualization after processing into the model
Industry dumb variable	Industry virtualization after processing into the model

Model

After the Hausman test, this paper chooses to use industry and year as fixed factors for the basic effects of the model on the basis of general multiple linear regression for basic effects regression. The model is constructed as follows.

Test whether the regression coefficient α between government subsidies and R&D investment is significantly positive. If model holds, the regression coefficient is significantly positive.

Model : $RD_{i,\ t} = \alpha_0 + \alpha_1^* SUB_{i,t} + \sum_k \gamma_k\, Control_{k,i,t} + Year, Industry\ fixed\ effects + \varepsilon_{i,t}$

RD is the R&D investment indicator, and SUB represents government subsidies. α_0 is the constant term, α_1 is the regression coefficient of the main variable, *Control* represents the control variables, γ is the regression coefficient of each control variable, and ε is the random error term. The subscripts *i* and *t* denote industry and year, respectively.

Descriptive statistics and Correlations

As shown in Table 2, the maximum value of R&D is 23.81 and the minimum value is 5.094, which indicates that the intensity of investment in R&D innovation varies among different enterprises; from the perspective of government subsidies, the standard deviation is 1.497, which indicates that the dispersion of the data is not high and shows that the state has introduced different government subsidy policies for enterprises of different sizes in various industries.

TABLE 2. Descriptive statistics

Variable	N	Mean	SD	Min	P50	Max
lnRD	17629	17.79	1.516	5.094	17.79	23.81
lnsub	17629	16.29	1.497	6.733	16.26	22.65
age	17629	16.59	5.721	2	16	61
BSS	17629	8.527	1.679	0	9	20
FL	17629	0.399	0.198	0.008	0.387	0.995
EPS	17629	0.369	0.656	-10.71	0.28	21.56
OC	17629	34.30	14.60	2.197	32.45	89.09
ROA	17629	0.045	0.069	-1.859	0.042	1.202

There is no multicollinearity between the variables in this model. From the Pearson correlation coefficient (Spearman rank correlation coefficient) in Table 3, it can be found that: the correlation coefficient between government subsidies of enterprises and R&D investment is 0.515 (0.532), which is significantly and positively correlated at the significance level of 0.01, i.e., government subsidies have a positive impact on enterprises' R&D investment, which tentatively proves hypothesis.

TABLE 3. Correlation analysis

	lnRD	lnsub	age	BBS	FL	EPS	OC	ROA
lnRD	1	0.532***	0.072***	0.102***	0.241***	0.213***	0.002	0.097***
lnsub	0.515***	1	0.135***	0.159***	0.356***	0.118***	0.067***	-0.024***
age	0.040***	0.114***	1	0.049***	0.169***	-0.048***	-0.074***	-0.095***
BBS	0.100***	0.176***	0.049***	1	0.140***	0.035***	0.002	-0.018**
FL	0.200***	0.341***	0.168***	0.165***	1	-0.154***	0.070***	-0.401***
EPS	0.176***	0.109***	0.001	0.038***	-0.135***	1	0.136***	0.842***
OC	0.042***	0.089***	-0.077***	0.025***	0.078***	0.118***	1	0.072***
ROA	0.089***	0.021***	-0.057***	0.005	-0.318***	0.692***	0.092***	1

Lower-triangular cells report Pearson's correlation coefficients, upper-triangular cells are Spearman's rank correlation
(*** p<0.01, ** p<0.05, * p<0.1)

IV. RESULTS

The regression results for lnsub and lnRD are presented in Table 4. Regression (1) controls only for the core explanatory variables, regression (2) also controls for year fixed effects and industry fixed effects in addition to the core explanatory variables, and regression (3) controls for other variables that may have an effect based on regression (2). adj-R2 is 0.1367, 0.3235, and 0.3366, respectively, which indicates that the model fits best when controlling for other variables, industry, and year. fit is the best. lnsub has a regression coefficient of 0.205, which passes the significance test at the 1% level, which indicates that the variable lnsub explains the variable lnRD very strongly. For each unit increase in the intensity of government subsidies lnsub, the intensity of firms' R&D investment lnRD also increases by 0.205 units. The overall experimental results support hypothesis.

1TABLE 4. Basal regression analysis

	(1)	(2)	(3)
VARIABLES	**lnRD**	**lnRD**	**lnRD**
lnsub	0.334***	0.226***	0.205***
	(56.127)	(21.425)	(20.358)
age			-0.004
			(-0.970)
BBS			0.060***
			(7.575)
FL			0.723***
			(8.107)
EPS			0.179***
			(7.316)
OC			0.001
			(0.462)
ROA			-0.175
			(-0.902)
Constant	12.233***	13.101***	12.534***
	(123.414)	(64.454)	(57.621)
Year/Industry	NO	YES	YES
Observations	17,629	17,629	17,629
N	3,010	3,010	3,010
Adj - R^2	0.1367	0.3235	0.3366

*** p<0.01, ** p<0.05, * p<0.1

V. DISCUSSION

Through empirical analysis, this paper finds that the leverage effect of government subsidies on R&D investment is obvious, and enterprises of different industries and sizes cannot invest in R&D without the external encouragement and support provided by the government. Government subsidies play an important role in compensating for the external losses of enterprises and providing conditions for product and service upgrading and strategic transformation of enterprises.

The increase in R&D investment means that enterprises increase their independent innovation, and the unique resources brought by their innovative achievements can make them form unique market competitiveness after being naturally different or even superior to other enterprises in the market competition, which in turn expands their market share and guarantees their business income.

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