Research on the Effect of Public R&D Subsidies on R&D Investment Expenditure of Technological Innovation Enterprises

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Abstract. As the product attribute of R&D investment, enterprises are lack of the enthusiasm of R&D investment. Public R&D subsidies may reduce the cost of R&D investment, and promote R&D investment of enterprises. However public R&D also has the extrusive effect to the R&D investment of enterprises. This paper presents evidence on the effects of public R&D subsidies on the R&D investment of technological innovation enterprises. The results show that public R&D subsidies can stimulate the R&D investment of enterprises. There also exist different effects of public R&D subsidies between different scales, proportion of state-owned shares and managerial ownership of enterprises.

1. Introduction

The R&D investment of technological innovation enterprises is characterized by high input, high risk and long term, and its achievements have public goods quality. If only with voluntary R&D investment of technological innovation enterprises, the level of R&D investment will below the best R&D investment level, so as to cause the market failure.

The governments have taken a positive measures to improve the R&D investment activities of enterprises by public R&D subsidies, tax incentive, subsidized interest. Although the aims of public R&D subsidies are to improve the spontaneous R&D investment of enterprises, the effects of public R&D subsidies can be complete opposite: stimulation effect and extrusion effect. If public R&D subsidies increase the enterprises' R&D investment, then stimulation effect works, otherwise extrusion effect works.(Levin, 1984; Wallsten, 2000).

2. Hypothesis

The investment of enterprise depends on expected return, risk and financial constraints in the market without government intervention. Therefore enterprises have no incentive to develop investment project with high risk and long period, especially in the case of the enterprises can not monopolize the proceeds of the investments. In fact R&D investment falls into this category. In order to improve R&D investment level, public R&D subsidies are needed to reduce the cost and risk of R&D investment and improve its expected return(Guellec etc. 2003; Hu, 1998).

Hypothesis 1a, public R&D subsidies will stimulate the technological innovation enterprises to invest in R&D projects.

On the other hand, the activities of technological innovation enterprises' R&D investment are differences in properties. Some kind of R&D investments is low risk with relatively high returns, some kind of R&D investment is important to the enterprises development, consequently enterprises will do it anyway. Therefore if public R&D subsidies are put on these projects, that will decrease the level of enterprises spontaneous R&D investments(Lichtenberg, 1987).

Hypothesis 1b: public R&D subsidies will crowd out the R&D investment of technological innovation enterprises.

The effect of public R&D subsidies on different kinds of technological innovation enterprises can be different, such as scale, proportion of state-owned shares,agency problem and so on.

Hypothesis 2a: the effect of public R&D subsidies on technological innovation enterprises R&D investment decrease with the enterprises scale increase.

Hypothesis 2b: the effect of public R&D subsidies on technological innovation enterprises R&D investment negatively correlate with proportion of state-owned shares of the enterprises.

Hypothesis 2c: the effect of public R&D subsidies on technological innovation enterprises R&D investment decrease with the agency problem of the enterprises increase.

3. The Model and the Variables

We assume the following equations to describe the effect of public R&D subsidies on enterprises R&D investment:

$$R \& D_{it} = f(GOV_{it}, size_{it}, CF_{it}, Lev_{it}, Executive_{it}, Roa_{it}, eps_{it}, growth_{it}) + \sum Year + \sum Ind + \varepsilon_{it} \quad (1)$$

$$R \& D_{it} = f(gov\_dum_{it}, size_{it}, CF_{it}, Lev_{it}, Executive_{it}, Roa_{it}, eps_{it}, growth_{it}) + \sum year + \sum Ind + \varepsilon_{it} \quad (2)$$

GOV_{it} or gov_dum_{it} is used as a proxy for the effect of public R&D subsidies, so that hypothesis 1a would suggest a positive and significant coefficient. Otherwise hypothesis 1b would be proved.

The description of variables are as follows:

1. The explained variable:

$R \& D_{it}$ is the R&D investment of listed technological innovation companies which is disclosed by the annual report. The information of R&D investment is reported in the main business of the annual report of listed companies. Because of the lack of data before 2010 annual report, we find the R&D investment in “administration expense” or “the cash flow related with business activities”.

2. The explanatory variables: GOV_{it} is the natural logarithm of the public R&D subsidies, which is the sum of R&D project subsidies, new products subsidies, innovation awards and so on. In order to avoid the sample selection bias, in model (2) the public R&D subsidies variable gov_dum_{it} is a dichotomous variable that takes the value of 1 if there is public R&D subsidies, and a null value if not.

3. The control variables: enterprise scale ($size_{it}$) is the natural logarithm of total asset, cash flow ratio (CF_{it}) is the ratio of “operating cash flow” to “fixed asset”, debt ratio (Lev_{it}) is the ratio of total debt to total asset, executives share ($Executive_{it}$) is a dummy variable, growth rate ($growth_{it}$) is the main business revenue growth.

4. Descriptive Statistics

Table 1 shows descriptive statistics for observations. In order to reduce the influence of outliers, we delete the data of each variables which is out of range 1% and 99%. Table 2 shows descriptive statistics in each year.

Table 1. Descriptive Statistics

Variables	Median	Mean	Std Dev	Minimum	Maximum
$R \& D_{it}$	17.42286	17.30836	1.736954	8.337466	22.90133
GOV_{it}	14.4033	14.36531	1.863658	7.090077	21.48748
$size_{it}$	21.53529	21.60844	1.239726	10.8422	26.64656
CF_{it}	0.1945464	0.2039045	2.677834	-123.8242	14.78063
Lev_{it}	0.4589497	0.6620081	4.392573	0.0290972	142.7178
$Executive_{it}$	0	0.0242041	0.0771209	0	0.6921961
Roa_{it}	0.0412595	0.0322985	1.344178	-64.81915	20.78764
eps_{it}	0.23	0.3485072	0.5364539	-2.72	6.28
$growth_{it}$	0.115937	0.3642874	2.372684	-1.605846	62.18187

Table 2. Descriptive Statistics by Year

year	samples			Samples with R&D		
	Firms Observations	R&D	Ratio	Firms Observations	Public R&D Subsidies	Ratio
2008	450	210	0.466667	210	134	0.638095
2009	451	359	0.796009	359	258	0.718663
2010	451	379	0.840355	379	283	0.746702
2011	451	422	0.935698	422	326	0.772512
2012	451	437	0.968958	437	358	0.819222
2013	449	431	0.959911	431	357	0.828306

5. Regression Results

5.1 Full Sample Results

The χ^2 results of hausman test on model (1) and model (2) are 19.94 and 19.49, so we use the random-effect model to regress. Table 3 shows that the results of the effect of public R&D subsidies on technological innovation enterprises R&D investments.

Table 3. Public R&D Subsidies Regression

	Model(1)		Model(2)	
	$R \& D_{it}$	$R \& D_{it+1}$	$R \& D_{it}$	$R \& D_{it+1}$
GOV_{it}	0.15*** (8.62)	0.03* (1.90)		
gov_dum _{it}			2.09*** (8.33)	0.433* (1.82)
size _{it}	0.33** (2.24)	0.54*** (3.72)	0.41*** (2.77)	0.56*** (3.83)
CF_{it}	0.02 (0.23)	0.16* (1.88)	0.02 (0.23)	0.16* (1.87)
Lev_{it}	-0.12* (-1.90)	-0.16** (-2.31)	-0.11* (-1.81)	-0.16** (-2.29)
$Executive_{it}$	6.29*** (3.64)	5.38*** (3.12)	6.34*** (3.66)	5.39*** (3.12)
Roa_{it}	-0.72 (-0.78)	-0.32 (-0.26)	-0.71 (-0.77)	-0.31 (-0.25)
eps _{it}	0.86*** (3.04)	0.60** (2.10)	0.87*** (3.09)	0.60** (2.10)
growth _{it}	0.00 (0.03)	-0.02 (-0.46)	0.000 (0.02)	-0.02 (-0.47)
Constant	-0.89 (-0.28)	1.20 (0.39)	-2.51 (-0.81)	0.87 (0.28)
Ind/year	Contra	Contra	Contra	Contra
R2-within	0.3966	0.1737	0.3961	0.1742
R2-between	0.1787	0.1590	0.1734	0.1563
Wald chi2	1520.61***	435.64	1513.95***	435.49***
N	2645	2195	2645	2195

***p < 0.01; **p < 0.05; *p < 0.1; z values in parentheses

Table 3 shows the result of our investigations into the impact of public R&D subsidies on technological innovation enterprises. The list 2 and 4 are the regressions of model (1) and (2) with $R\&D_{it}$, and the list 3 and 5 are the regressions with $R\&D_{it+1}$, which is the lag of R&D investment.

Table 3 shows that the coefficient of GOV_{it} and gov_dum_{it} are positive and significant at the 1% significance level, hypothesis 1a is proved. The financial market of China is developing, where the innovation can not be fully protected. So that the technological innovation enterprises don't have much enthusiasm to invest in R&D project. Public R&D subsidies which can reduce the cost and risk of R&D investment will improve the level of voluntary R&D investment efficiently.

5.2 Grouped Samples Results

(1) Scale

To test hypothesis 2a, we regress the effect of public R&D subsidies on different scale of enterprises which is grouped by median. Table 4 shows the results.

Table 4. Public R&D Subsidies Regression by Scale

	Large-scale		Small-scale	
	Model(1)	Model(2)	Model(1)	Model(2)
GOV_{it}	0.10*** (4.15)		0.19*** (7.79)	
gov_dum_{it}		1.44*** (3.81)		2.48*** (7.57)
$size_{it}$	0.42* (1.76)	0.48** (1.99)	0.31* (1.71)	0.38** (1.93)
CF_{it}	-0.23 (-1.16)	-0.23 (-1.18)	-0.02 (-0.23)	-0.02 (-0.21)
Lev_{it}	0.46 (0.38)	0.47 (0.38)	-0.14* (-1.90)	-0.14* (-1.84)
$Executive_{it}$	5.30** (2.56)	5.31** (2.51)	4.57** (2.30)	4.68** (2.36)
Roa_{it}	2.34 (0.49)	2.63 (0.56)	-1.52 (-1.48)	-1.50 (-1.46)
eps_{it}	0.41** (1.96)	0.41** (1.94)	2.15*** (3.81)	2.18*** (3.85)
$growth_{it}$	0.01 (0.15)	0.01 (0.11)	0.02 (0.37)	0.03 (0.44)
Constant	-3.40 (-0.66)	-4.66 (-0.90)	6.73 (0.91)	4.90 (0.66)
Ind	Control	Control	Control	Control
year	Control	Control	Control	Control
R2-within	0.3705	0.3696	0.3943	0.3934
R2-between	0.2451	0.2419	0.2502	0.2470
Wald chi2	642.97***	639.36***	755.15***	750.16***
N	1337	1337	1308	1308

***p < 0.01; **p < 0.05; *p < 0.1; z values in parentheses

Table 4 shows there exist significant differences between large-scale group and small-scale group. The public R&D subsidies have more obvious influence on small technological innovation enterprises than large ones, hypothesis 2a is proved.

(2) State-Owned Shares

To test hypothesis 2b, we regress the effect of public R&D subsidies on different proportions of state-owned shares which is grouped by median. Table 5 shows the results.

Table 5. Public R&D Subsidies Regression by State-Owned Shares

	High		Low	
	Model(1)	Model(2)	Model(1)	Model(2)
GOV_{it}	0.12*** (3.61)		0.15*** (7.55)	
gov_dum_{it}		1.63 (3.38)		2.14*** (7.30)
$size_{it}$	0.44* (1.65)	0.50* (1.87)	0.34** (2.07)	0.42** (2.52)
CF_{it}	-0.25 (-0.75)	-0.27 (-0.80)	0.01 (0.09)	0.01 (0.12)
Lev_{it}	-0.92** (-2.36)	-0.91** (-2.34)	-0.12* (-1.87)	-0.12* (-1.78)
$Executive_{it}$	7.66* (1.68)	7.54* (1.79)	6.28*** (3.66)	6.34*** (3.68)
Roa_{it}	1.91 (0.97)	1.91 (0.96)	-0.98 (-0.92)	-0.94 (-0.88)
eps_{it}	0.51 (0.97)	0.51 (0.97)	1.05*** (3.12)	1.08*** (3.21)
$growth_{it}$	-0.02 (-0.30)	-0.02 (-0.34)	0.00 (0.07)	0.00 (0.10)
Constant	-3.10 (-0.55)	-4.30 (-0.76)	-0.49 (-0.14)	-2.07 (-0.59)
Ind/year	Control	Control	Control	Control
R2-within	0.4401	0.4394	0.3125	0.3124
R2-between	0.4083	0.4064	0.2344	0.2285
Wald chi2	555.22***	552.60***	756.66***	752.43***
N	785	785	1860	1860

***p < 0.01; **p < 0.05; *p < 0.1; z values in parentheses

Table 5 shows there exist significant differences between high state-owned shares group and low state-owned shares group. Hypothesis 2b is proved.

(3) Management Ownership

To test hypothesis 2c, we regress the effect of public R&D subsidies on different scale of management ownership which is grouped by median. Table 6 shows the results.

Table 6. Public R&D Subsidies Regression by Management Ownership

	High management ownership		Low management ownership	
	Model(1)	Model(2)	Model(1)	Model(2)
GOV_{it}	0.12*** (4.68)		0.16*** (6.72)	
gov_dum_{it}		1.61*** (4.32)		2.26*** (6.68)
$size_{it}$	0.14 (0.65)	0.21 (0.93)	0.67*** (3.49)	0.75*** (3.94)
CF_{it}	-0.14 (-0.59)	-0.14 (-0.59)	-0.04 (-0.50)	-0.04 (-0.54)
Lev_{it}	-0.26 (-0.52)	-0.24 (-0.47)	-0.11* (-1.65)	-0.10 (-1.57)
$Executive_{it}$	4.74*** (2.66)	4.81*** (2.69)	-3.15 (-0.15)	-3.88 (-0.18)
Roa_{it}	12.63*** (2.97)	13.01*** (3.06)	-1.35 (-1.38)	-1.36 (-1.39)
eps_{it}	-0.52 (-0.88)	-0.53 (0.89)	0.90** (2.49)	0.90** (2.49)
$growth_{it}$	0.040 (0.43)	0.04 (0.37)	-0.01 (-0.31)	-0.01 (-0.28)
Constant	4.40 (0.94)	3.10 (0.66)	-9.55** (-2.34)	-11.33*** (-2.78)
Ind/year	Control	Control	Control	Control
R ² -within	0.3135	0.3118	0.4620	0.4627
R ² -between	0.3235	0.3241	0.2462	0.2406
Wald chi2	575.16***	570.49***	966.46***	967.14***
N	1329	1329	1316	1316

***p < 0.01; **p < 0.05; *p < 0.1; z values in parentheses

Table 6 shows there exist significant differences between high management ownership group and low management ownership group. Hypothesis 2c is proved.

6. Conclusion

This paper studies the effect of public R&D subsidies on R&D investment of technological innovation enterprises. R&D investment is characterized by high risk and long period, so that technological innovation enterprises have no incentive to do it. The result shows that public R&D subsidies can improve the level of R&D activities of technological innovation enterprises. It also shows that public R&D subsidies have different effect on different kind of technological innovation enterprises

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