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The Role of Research and Development Investment in Company Growth

-- Empirical Evidence based on the Guangzhou Region

Zhang Gang[1, 2], Julie Ann U. Abellera[2, *]

[1] Guangzhou College of Commerce, Guangzhou 511363, China

[2] University of the Cordilleras, Gov. Pack Rd, Baguio, Benguet, Philippines

[*]Corresponding author: Julie Ann U. Abellera (Email: juabellera@uc-bcf.edu.ph. |(+63) 921 713 2457)

Abstract

Research and development (R&D) are becoming increasingly crucial as the advent of the dual carbon era ushers in a new round of technological revolution, placing enormous pressure on various industries. In response to potential industry reshuffling and industrial chain restructuring, enterprises are intensifying their focus on R&D, resulting in a massive surge of activity. However, is it necessary for all industries to participate? Can all R&D investments drive business growth? This article selects data from manufacturing enterprises in Guangzhou, the holy land of China's reform and opening up, from 2012 to 2022 to empirically demonstrate that R&D investment has not brought expected results and is negatively correlated with enterprise growth. This conclusion serves as a warning to businesses in panic and following the trend. This has important reference significance for corporate governance and scientific decision-making.

Keywords

R&D Investment; Company Growth; Regional Economy; Sustainable Operation.

1. Introduction

After experiencing several waves of technological revolution, humans have deeply believed in the promoting role of technology and economy, and even reached a level of worship. When discussing development and governance in various industries, innovation is necessary. The official entry into force of the Paris Agreement signifies the arrival of the dual carbon era, and countries have initiated a new round of technological revolution and economic restructuring. China also proposed the goal of a beautiful China and the concept of new quality productivity in 2023. But has the investment in innovation really achieved the expected results? This article selects enterprise data from Guangzhou, the holy land of China's reform and opening up, from 2012 to 2022 for empirical testing.

2. Literature Review

Regarding the role of R&D investment in company growth, foreign scholars have studied it earlier. Early research on technological innovation and R&D investment mainly focused on the investment of R&D funds (R&D intensity), and mostly focused on the macro level. The correlation between R&D investment and corporate performance. Griliches (1986) used the Cobb Douglas production function to examine the impact of research and development spending on productivity by approximately 1000 of the largest manufacturing companies in the United States from 1957 to 1977[6]. The research results all indicate that R&D expenditure has

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a significant contribution to the improvement of productivity and performance of American enterprises. At the micro level, the variable that has the greatest impact on the intensity of R&D investment in enterprises is enterprise size. Cohen and Levi (1989) found in their empirical study that firm size and industry structure have a significant impact on firm R&D activities[6]. Cohen and Klepper (1992) argue that firm size and an unobservable stochastic process jointly determine R&D density and costs[7]. Based on this conclusion, Chang Yang Lee (2002) further found that the main determinant of R&D density is the technological competitiveness of enterprises, and the size of enterprises is indirectly linked to R&D density through technological competitiveness[6]. However, there are also some opposing views that believe that large companies do not have any advantage in the R&D competition (Kamein Schwartz, 1982)[6]. They believe that due to difficulties in internal communication within large companies and insufficient motivation to encourage R&D personnel, the efficiency of R&D in large companies is low. In terms of corporate governance structure, it has been proven that the equity structure, incentive mechanism, leadership structure, and senior management are all related to R&D expenses. Levin, Klevorick, Nelson, and Winter (1987) argue through theoretical and empirical analysis that the equity structure, incentive mechanism, leadership structure, and learning ability of a company are important influencing factors on its R&D activities[6].

In recent years, most of the research on R&D has been conducted by Chinese scholars, while domestic scholars have conducted empirical research on R&D investment based on foreign scholars and combined it with the actual situation in China. Firstly, in terms of macro environment. The empirical results of Chen Feixiang, Chen Guoliang, and Hu Jing (2005) indicate that from the perspective of maintaining long-term stable development of the national economy, China should further improve the domestic market environment to effectively encourage foreign-funded enterprises to carry out more R&D activities in China[6]. Secondly, many studies have also started from the micro enterprise level, mainly focusing on the correlation between R&D investment and various development capacity indicators of enterprises. Liang Laixin and Zhang Huanfeng (2005) randomly selected 150 high-tech listed companies in 2001, and selected 72 of them to conduct empirical research on R&D investment performance through three indicators: profitability, development ability, and technological innovation ability[6]. They pointed out that there is a strong correlation between R&D investment intensity and main business profitability, but the input-output effect has a significant lag. Liu Di and Yin Heng (2016) Research has shown that there is indeed uncertainty, nonlinearity, and enterprise heterogeneity in R&D investment and return[2]. Li Jun's (2023) study on emerging listed companies in the Yangtze River Delta region shows that there is a U-shaped relationship between current R&D investment and corporate growth, with a significant positive correlation between lagged R&D investment and corporate growth[1]; There is a significant positive correlation between government subsidies, management shareholding, and research and development investment. (Wang Yang and Lan Zhiqing, 2024) conducted a study on the relationship between R&D intensity and company total asset return rate[6]. The study found that there were significant differences in the marginal coefficient sign and significance of R&D investment on corporate performance at different threshold ranges.

Scholars from various countries have conducted numerous studies from different dimensions, but have failed to reveal the quantitative relationship between R&D investment and company profit. However, directly studying the quantitative relationship between R&D investment and total company profit without changing the variables may be more informative.

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3. Research Design

This article selects data from 56 listed companies in Guangzhou, China from 2012 to 2022 to construct a panel regression model on the impact of R&D on company growth. The relevant raw data mainly comes from financial terminals of iFind and CSMAR.

3.1. Model Establishment

Through preliminary sorting of raw data, it was found that the R&D investment and total profit of companies in the Guangzhou region have shown an overall upward trend in the past decade. Is it because R&D has promoted profit growth or is it because profit growth has the conditions to increase R&D investment? Is there a correlation between the two? Therefore, to further explore its underlying reasons, this study proposes the following hypotheses:

H0: There is a positive correlation between R&D investment and profit growth;

H1: Technological growth positively regulates R&D investment and profit growth;

H2: Social responsibility positively regulates the positive correlation between research and development investment and profit growth;

H3: The interaction between social responsibility and technological growth affects research and development investment and profit growth.

To verify the above hypothesis, the following model is constructed at three levels:

First level

(1) $INCit=a0+\beta1ASSET\ it + \beta2NPit+\beta3RDit-1+\mu it$

(2) $INCit=a0+\beta1ASSET\ it + \beta2NPit+\beta3TECit+ \mu it$

(3) $INCit=a0+\beta1ASSET\ it + \beta2NPit+\beta3CSRit+ \mu it$

Second level

(4) $INCit =a0+\beta1ASSET\ it + \beta2NPit+\beta3RDit-1+\beta4TECit+\mu it$

(5) $INCit =a0+\beta1ASSET\ it + \beta2NPit+\beta3RDit-1+\beta4CSRit+ \mu it$

Third level

(6) $INCit = a0+\beta1ASSET\ it + \beta2NPit+\beta3RDit-1+\beta4TECit+\beta5RDit-1 * TECit+\mu it$

(7) $INCit = a0+\beta1ASSET\ it + \beta2NPit+\beta3RDit-1+\beta4CSRit+\beta5RDit * CSRit+\mu it$

(8) $INCit = a0+\beta1ASSET\ it + \beta2NPit+\beta3RDit-1+\beta3TECit+\beta4CSRit+\beta4RDit-1*TECit+\beta5RDit-1 * CSRit+\beta6TECit * CSRi+\mu it$

The first level tests the impact of independent and moderating variables on the dependent variable, the second level tests the impact of moderating variables on the independent variable, and the third level tests the impact of the interaction between independent and moderating variables on the dependent variable.

3.2. Variable Description

There are two methods for measuring the growth of enterprises: single indicator method and comprehensive indicator method. Single standard method, such as measuring annual total profit, growth rate of operating revenue, etc,; The comprehensive indicator method and principal component analysis method construct growth indicators from the perspectives of profitability, development ability, debt repayment ability, and cash flow. Both methods have their own advantages and disadvantages. This article mainly studies the quantitative relationship between the total profit of enterprises and R&D investment. Therefore, a single indicator is selected to measure the growth of enterprises, and relevant moderating variables and control variables are added to the robustness test. The specific descriptions of each variable are as follows (Table 1).

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Table 1. Variable definition table

Variable type	Variable name	Variable meaning	Measurement method
dependent variable	INC	Enterprise qrowth level	the total profit
independent variable	RD	Enterp rise R&D investment Ievel	Total investment in research and development
regulated variable	CSR	Perfo rmance of corporate social	Corporate social responsibility expenditure
	TEC	Technolcaical arowth level ofenterprises	Software and hardware fadlities level
	RD&TEC	interaction between RSD investment and technaoaical aro wth	RD*TEC
COVARIATE	RD&CSR	Interaction between RSD investment and sodial responsibility	RD*CSR
	TEC&CSR	Interaction between Technoloqical Growth and social responsibility	TEC*CSR
	ASSET	Enterprise asset scale	Total assets of enterprise
Control variable	NP	Enterprise employee's scale	Total number of emlployees in enterprises
random error	μ	random error	Model residual

3.3. Descriptive Statistics

Based on the aforementioned research design and sample data, this study analyzed, organized, classified, summarized, and denoised the original data. The relevant sample characteristics are described as follows:

Table 2. Descriptive Statistics

Variable	N	Mean	SD	Min	Max
INC	543	285442.59060	119720.15136	0	1.44367E+06
Rd	543	1.83994E+08	5.77082E+08	0	6.52600E+09
TEC	543	3.09186E+09	5.45217E+08	0	8.45566E+09
CSR	543	1.33994E+06	4.23317E+06	0	4.28690E+07

As shown in the table above, the total number of observations for each variable is 543. Among them, the maximum values of explanatory variables and related moderating variables differ greatly from their means, and the standard deviation of each variable is also large, indicating a large trend of data dispersion, indicating that there are significant differences among the above variables among companies, and there is a large elastic space for most companies. So is there any correlation between the above variables?

4. Empirical Analysis

4.1. Correlation Analysis

This study conducted a correlation analysis using STATA 18 statistical software, and the results are as follows:

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Table 3. Pearson and Spearman Relationships

Variable	INC	Rd	TEC	CSR
INC	1.0000	0.7818 * *	0.8301 * *	0.7600 * * *
Rd	0.5935 * *	1.0000	0.7606 * *	0.8320 * * *
TEC	0.9037 * *	0.3700 * *	1.0000	0.7175 * * *
CSR	0.5026 * *	0.5737 * *	0.3004 * *	1.0000

Upper Spearman; Lower Pearson * p<0.1, * * p<0.05, * * * p<0.01

Table 3 shows a significant positive correlation between R&D investment and corporate growth at the 1% level, as R&D investment lags behind and the relationship between the two needs further analysis.

Considering the lag in the transmission of R&D, this study refers to (Li Jun, 2023) and involves the analysis of R&D with a lag of one period.[1] The correlation coefficients of R&D variables with a lag of one period are as follows:

Table 4. Pearson and Spearman Relationships

Variable	INC	LRd	TEC	CSR
INC	1.0000	0.3958 * *	0.3455 * *	0.4447 * * *
LRd	0.7618 * *	1.0000	0.2813 * *	0.5355 * * *
TEC	0.5605 * *	0.6595 * *	1.0000	0.2883 * * *
CSR	0.6320 * *	0.5504 * *	0.3743 * *	1.0000

Upper Spearman; Lower Pearson *P<0.1, * * p<0.05, * * * p<0.01

From Table 3-7, it can be seen that the relationship between hysteresis Rd and INC has significantly increased from 0.5935 to 0.7618, an increase of 28.36%. The hysteresis conduction effect of RD is significant.

The lower left corner of the table shows the Pearson correlation coefficient, and the upper right corner shows the Spearman correlation coefficient. From the table, it can be seen that both the Pearson correlation coefficient and Spearman correlation coefficient of the above variables are significantly and positively correlated at the 1% level. From a data perspective, R&D has the highest correlation with the dependent variable among the above coefficients, followed by CSR. This may be the result of a responsible enterprise helping to establish a positive public image and bringing a virtuous cycle to the enterprise in various aspects. Finally, there is TEC. From an economic logic perspective, this is mainly because TEC is the carrier of R&D, and to convert it into productivity, it needs to be achieved through R&D, because R&D is the internal driving force.

4.2. Regression Analysis of the Impact of RD Investment on Corporate Growth

In order to further explore the relationships between the above variables and identify their quantitative relationships and properties, based on the construction of the model, this study used STATA 18 software to analyze and process the above sample data sequentially using panel regression. The first to third level regression results are as follows.

First level regression results:

The first level regression results indicate that, under the premise of controlling for enterprise assets and employee size, the above variables have an independent impact on INC. CSR has a positive moderating effect on INC. This indicates that good CSR and RD have a significant impact on INC, while TEC has no significant impact. This is mainly because TEC cannot be separated from RD and plays a decisive role independently, as it is only a tool and means. The above

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models 1 and 3 are valid, indicating that hypothesis H2 is valid. H0 does not hold true when R&D investment lags by one period, and the quadratic relationship between RD and lagged RD is significantly negatively correlated with INC at the 1% level. Li Jun, 2023, found that there is a U-shaped relationship between current RD and enterprise growth[1]. Only when RD investment reaches a certain level, such as the power of RD, is there a significant positive correlation between RD and enterprise growth, which is not consistent. However, this study did not prove this point when using R&D2 lagged by one period R&D2 (see columns 4-5 of Table 3-8), indicating that H0 is not valid in the sample data of companies in Guangzhou during the period of 2012-2022.

Table 5. merged with m1-m3

model	m1	m2	m3	
var.	INC	INC	INC	
l_Rd	-0.00006***			
	(-4.08016)			
ASSET	536.24766***	391.21673***	365.74106***	
	-12.09943	-14.65718	-14.98705	
NP	3.16691***	2.90573***	2.25703***	
	-8.14966	-7.71513	-5.84802	
TEC		0		
		(-0.29984)		
CSR			0.00414***	
			-5.16923	
_cons	2.45e+05***	2.52e+05***	2.45e+05***	
	-79.43382	-13.07323	-88.16587	
N	487	543	543	
R^2	0.7514	0.73842	0.75073	
adj. R^2	0.74986	0.73696	0.74934	
t statistics in parentheses		* p < 0.10, ** p < 0.05, *** p < 0.01		

The second level regression results are as follows:

Table 6. Merge of m4-m5

model	m4	m5
var.	INC	INC
l_Rd	-0.00007***	-0.00006***
	(-4.24745)	(-3.82329)
ASSET	524.59038***	505.38924***
	-11.69721	-11.46209
NP	3.12227***	2.57752***
	-8.02686	-6.36622
TEC	0.00001	
	-1.59665	
CSR		0.00364***
		-4.35333
_cons	2.11e+05***	2.44e+05***
	-9.68048	-80.31479
N	487	487
R^2	0.75271	0.76081
adj. R^2	0.75066	0.75882
t statistics in parentheses		
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$		

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The above table shows the moderating effects of TEC and CSR on INC after controlling for enterprise assets and employee size. The results show that TEC has a certain negative impact, but the effect is not significant, while CSR has a more significant impact on current INC. This is mainly due to the different treatment methods of accounting standards for the two. According to the current standards, TEC is recognized as current assets, while CSR is directly recognized in current profit and loss.

The results of the third level regression (see Table 7),

Table 7. M6-M8 merged

model	m6	m7	m8
var.	INC	INC	INC
l_Rd	-0.00006**	-0.00006***	0.00004
	(-2.23216)	(-3.16057)	-1.22179
ASSET	523.14462***	502.73546***	460.86677***
	-11.50191	-10.72971	-10.12271
NP	3.09484***	2.59828***	1.21510**
	-7.48779	-6.13458	-2.57922
TEC	0.00001		-0.00001
	-1.35312		(-1.21918)
CSR		0.00374***	-0.01525***
		-3.63591	(-5.29101)
l_RdTEC	0		-0.00000**
	(-0.19781)		(-2.54739)
l_RdCSR		0	-0.00000***
		(-0.16876)	(-4.63539)
TEC_CSR			0.00000***
			-7.13341
_cons	2.07e+05***	2.44e+05***	2.79e+05***
	-7.22162	-75.92416	-9.88924
N	487	487	487
R^2	0.75273	0.76082	0.78525
adj. R^2	0.75016	0.75833	0.78165
t statistics in parentheses		* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$	

According to Table 7, when observing the interaction between technological growth and lagged R&D investment, as well as the interaction between corporate social responsibility and lagged R&D investment, under the control of enterprise assets and employee size, the interaction between technological growth and R&D investment is only significant at the 10% level, while the interaction between corporate social responsibility and lagged R&D investment is not significant. Only when all the above variables are included simultaneously, the interaction between R&D investment, technological growth, and social responsibility is significant at the 5% and 1% levels, respectively, and the interaction between technological growth and social responsibility is significant at the 1% level, indicating the validity of Model (8).

4.3. Panel Regression Model Significance Test

To further test the effectiveness and robustness of model (8), this study used OLS regression and panel regression methods to validate the full sample data of companies in Guangzhou.

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Firstly, assuming that there is no correlation between these variables and that they change purely over time, i.e., they are independent of the variables, this study used Pool regression and cluster robust standard error analysis. The regression results with and without control variables are as follows:

Table 8. Uncontrolled Variable Pool Regression

reg INC l_Rd TEC CSR,vce(cluster id)

Linear regression

Number of obs = 487
F(3, 55) = 236.87
Prob > F = 0.0000
R-squared = 0.6553
Root MSE = 74133

(Std. err. adjusted for 56 clusters in id)

		Robust				
INC	Coefficent	std. err.	t	p >| t |	[95% conf.	Interval]
l_Rd	0.0001214	0.0000207	5.85	0	0.0000798	0.000163
TEC	0.000033	0.0000302	1.09	0.279	-0.0000275	0.0000935
CSR	0.0083128	0.0024522	3.39	0.001	0.0033984	0.0132272
_cons	153671.5	88352.46	1.74	0.088	-23390.8	330733.8

Table 9. Adding Control Variable Pool Regression

reg INC LRd TEC CSR LRd_TEC LRd_CSR TEC_CSR ASSET NP

source	ss	df	ms
Model	6.0467E+12	8	7.5583E+11
Residual	1.6537E+12	478	3.4595E+09
Total	7.7003E+12	486	1.5844E+10

Number of obs = 487
F(8, 478) = 218.48
Prob > F = 0.0000
R-squared = 0.7852
Adj R-squared = 0.7817
Root MSE = 58818

INC	Coefficient	Std. err.	t	p>| t |	[95% conf.	Interval]
LRd	0.0000365	0.0000299	1.22	0.222	-0.000022	0.0000952
TEC	-0.0000114	9.37E-06	-1.22	0.223	-0.0000298	6.99E-06
CSR	-0.0152473	0.0028817	-5.29	0	-0.0209097	-0.0095849
LRd_TEC	-1.03E-14	4.05E-15	-2.55	0.011	-1.83E-14	-2.36E-15
LRd_CSR	-3.61E-12	7.78E-13	-4.64	0.000	-5.14E-12	-2.08E-12
TEC_CSR	6.38E-12	8.94E-13	7.13	0.000	4.62E-12	8.13E-12
ASSET	460.8668	45.52801	10.72	0.000	371.407	550.3265
NP	1.215099	0.4711103	2.58	0.010	0.2893961	2.140802
_cons	279492	28262.23	9.89	0.000	223958.4	335025.5

According to Tables 8 and 9, it can be seen that when using cluster robust standard error method for Pool regression considering intra group autocorrelation, the p-value is significant, indicating the rejection of the null hypothesis that there is no individual effect, indicating that the correlation between variables is caused by individuals, indicating the existence of individual effect. For this purpose, further individual effect testing was conducted on the relevant panel data, and the results are as follows: RD is positively correlated in robust individual effects,As shown in Table.

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Table 10. individual effect testing without control variables

```
xtreg INC l_Rd TEC CSR, fe r
Fixed-effects (within) regression       Number of obs   =  487
Group variable: id                      Number of groups =  56
R-squared:                              Obs per group:
     Within  = 0.1415                           min = 2
     Between = 0.8477                           avg = 8.7
     Overall = 0.6549                           max = 10
                                        F(3, 55)  =  9.14
corr(u_i, Xb) = 0.6612                  Prob > F  =  0.0001
                    (Std. err. adjusted for 56 clusters in id)
------------------------------------------------------------------------------
             |               Robust
         INC | Coefficient  std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
        l_Rd |   .0000806   .000027     2.99   0.004     .0000266    .0001347
         TEC |    .000017   .0000276    0.62   0.540    -.0000384    .0000724
         CSR |   .0053395   .0027543    1.94   0.058    -.0001803    .0108592
       _cons |   214314.6   82604.93     2.59   0.012     48770.67    379858.6
-------------+----------------------------------------------------------------
     sigma_u |  54105.872
     sigma_e |  65113.311
         rho |    .408451   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Table 11. Panel Individual Effects with Control Variables

Xtreg INC LRd TEC CSR LRd_TEC LRd_CSR TEC_CSR ASSET NP,fe
Fixed-effects (within) regression Number of obs = 487
Group variable id Number of groups = 56
R-squared Obs per group:
Within = 0.5320 min = 2
Bwteen = 0.8863 avg = 8.7
Overal = 0.7766 max= 10
F(8,423) = 60.10
Corr(u_i,Xb)=-0.7573 Prob > F = 0.0000

INC	Coefficient	Std. err.	t	p>| t |	[95% conf. interval }	
LRd	-0.0000516	0.0000358	-1.44	0.150	-0.0001219	0.0000187
TEC	-0.0000254	8.62E-06	-2.94	0.003	-0.0000423	-8.43E-06
CSR	-0.0164265	0.0025921	-6.34	0.000	-0.0215215	-0.0113316
LRd_TEC	-9.12E-15	4.15E-15	-2.20	0.028	-1.73E-14	-9.68E-16
LRd_CSR	-3.25E-12	7.17E-13	-4.53	0.000	-4.65E-12	-1.84E-12
TEC_CSR	6.40E-12	7.97E-13	8.03	0.000	4.83E-12	7.96E-12
ASSET	860.0486	63.56664	13.53	0.000	735.1028	984.9945
NP	2.314337	0.7901921	2.93	0.004	0.7611445	3.867529
_cons	304380.10	25875.13	11.76	0.000	253520.30	355240
sigma_u	56244.498					
sigma_e	48359.705					
rho	0.57495154	(fraction of variance due to u_i)				
F test that all u_i = 0 : F(55,423)=5.17						

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To further identify the underlying reasons for the existence of individual effects, time effect estimation was performed, and the results showed a significant P-value of 0. To save space in the undisclosed analysis process, the F-statistic for time effect testing was. 42173682, which is less than the critical value of 1.9781513, indicating that the null hypothesis of time effects should be rejected, that is, there is no time effect in the entire sample data. But is this fixed effect caused by random factors? Further Hausman test was performed on the entire sample data, and the results are as follows:

The Hausman test shows: [b=Consistent under H0 and Ha; observed from xtreg.]

B=Inconsistent under Ha, effective under H0; Observed from xtreg

Test of H0: Difference in benefits not systemic

Chi2 (2)=(b-B) '[(V-b-V-B) ^ (-1)] (b-B)

=39.71

Prob>chi2=0.0000

From this, it can be seen that in the study of the effect of full sample data RD on company growth in Guangzhou, there are fixed effects on various variables, which are not caused by random factors.

Table 12. Combined Table of Fixed Effects, Random Effects, and Hausman Test

model	FE	RE	hausman
var.	INC	INC	INC
l_Rd	-0.00005	0.00003	0.00003
	(-1.44288)	-1.15298	-1.15298
TEC	-0.00003***	-0.00001	-0.00001
	(-2.94342)	(-1.37215)	(-1.37215)
CSR	-0.01643***	-0.01586***	-0.01586***
	(-6.33718)	(-5.61340)	(-5.61340)
l_RdTEC	-0.00000**	-0.00000***	-0.00000***
	(-2.19897)	(-2.74060)	(-2.74060)
l_RdCSR	-0.00000***	-0.00000***	-0.00000***
	(-4.53035)	(-4.62033)	(-4.62033)
TEC_CSR	0.00000***	0.00000***	0.00000***
	-8.03067	-7.40879	-7.40879
ASSET	860.04865***	488.56957***	488.56957***
	-13.52987	-10.51675	-10.51675
NP	2.31434***	1.05728**	1.05728**
	-2.92883	-2.21486	-2.21486
_cons	3.04e+05***	2.83e+05***	2.83e+05***
	-11.76342	-10.16889	-10.16889
N	487	487	487
R^2	0.53196		
adj. R^2	0.46225		
t statistics in parentheses		* p < 0.10, ** p < 0.05, *** p < 0.01	

5. Research Findings

Through the presentation and analysis of relevant data on R&D investment, technological growth, and social responsibility company growth in Guangzhou, the study found that the

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return on R&D investment in enterprises is not high or even negative. There is indeed uncertainty, nonlinearity, and heterogeneity between R&D and return, which is consistent with the research of Yin Heng and Liu Di (2016)[2]. The specific situation is as follows:

(1) Without the inclusion of relevant control variables, social responsibility is positively correlated with company growth at the 1% level, and there is a significant negative correlation between lagged R&D investment and company growth at the 1% level. Even when R&D investment reaches a certain level, such as the power of R&D investment, there is a significant negative correlation, while asset investment reflecting technological growth has no significant impact on the total profit of the current period.

(2) Without adding relevant control variables, the moderating effect of technological growth on R&D investment is not significant, while social responsibility indicators have a positive moderating effect on R&D investment.

(3) After adding all variables, the study found that corporate assets and employee size have a significant positive impact on corporate growth at the 1% level, while the interaction between social responsibility and technological growth positively moderates the impact of R&D investment on corporate growth at the 1% level. Social responsibility and lagged R&D investment significantly negatively regulate corporate growth at the 1% level, while lagged R&D investment and technological growth interact negatively at the 5% level, and there is no time effect.

(4) After adding all variables, the Millsman test showed that a fixed effects model was used, indicating that each explanatory variable had individual effects and was significantly correlated with the dependent variable.

(5) There is a significant positive correlation between current RD and corporate growth at the 1% level, but the Millsman test shows that there is a random relationship between the two and no long-term fixed effect.

(6) When examining the relationship between R&D investment and company growth in Guangzhou by industry, it was found that there was no significant heterogeneity among industries. The relationship between the two is unrelated to the sub sectors of the manufacturing industry.

(7) When testing by listed sectors, it was found that only the BJ sector had a positive correlation with delayed R&D investment and company growth, but it was not significant. Other sectors had a significant negative correlation at the 1% level.

The above research findings have also been confirmed to some extent by other scholars, Wang Yang and Lan Zhiqing (2024) The statistical research on the impact of R&D investment on corporate performance shows that the density of R&D investment in enterprises is not a single positive or negative correlation with corporate performance. The surface is inter regional, sometimes positive or sometimes negative.

6. Conclusion and Recommendations

1). Whether R&D investment is necessary and whether it can have a positive promoting effect is a prerequisite. It is necessary for technology driven enterprises, and caution should be exercised in industries such as traditional manufacturing that have low technological content or slow technological iteration.

2). There are many factors that affect the growth of enterprises, and enterprises should identify the key factors for success in their industry, with a focus on strengthening and breaking through. Attention should be paid to R&D investment in technology driven industries, and cautious and moderate control should be exercised in factor driven industries.

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3). Enterprises are profit oriented organizations, and modern society is a highly specialized society. Professional people do professional work, and even if research and development is needed, they can cooperate with relevant institutions such as research institutes to improve the quality and accuracy of research and development, and minimize and avoid research and development risks as much as possible.[5]

4). Strengthening industry university research cooperation and regional corporate governance exchanges, enterprises should fully utilize regional advantages to strengthen cooperation with universities and research institutes, and introduce promising scientific research projects. Li Jun's (2023) research shows that most companies with a close relationship between R&D investment and corporate growth have a university background[1]. Research and development activities themselves carry high risks and great uncertainty. To ensure the effective utilization of funds, it is necessary to establish an effective decision-making and execution mechanism. Therefore, corporate governance largely affects the strength of the relationship between R&D investment and company growth. Communicating with excellent enterprises and learning about corporate governance measures can help improve research and development investment and its effectiveness.

Finally, it should be pointed out that the above suggestions and measures need to be taken in a mutually beneficial manner by enterprises and governments, working together to achieve better results.

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