Business Strategy and R&D Expenditures

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Abstract

This research testifies that there is a positive relationship between business strategy and R&D expenditures based on the data from the listed firms in China. The paper also finds that the management myopic behaviour would make the firms reduce the R&D spending when the strategy score is in the higher level. Furthermore, the research shows the positive relationship between strategy and R&D expenditures still exits when the firms are SOEs and the firms have medium or high level of internal control quality. The result is robustness even after making the endogeneity tests.

Keywords: business strategy, R&D expenditures, real earnings management

1. Introduction

Business strategy is a comprehensive plan to desire the firm's internal rules and policies for the alignment with its potential change of environments (Hambrick, 1983). In the literature, there are some strategy theories to express similar classification. Porter (1980) indicates that the firms can be classified into cost-leadership or product differentiation. March (1991) gives quite similar strategy typology that the strategy can be set into exploitative and explorative. While, Treacy and Wiersema (1995) believes that the classification can be divided into operational excellence, product leadership and customer intimacy. This research applies for the Miles and Snow's strategy classification that prospectors, analyzers, defenders and reactors (Miles and Snow, 1978). Consistent with prior studies, this paper emphasizes on two endpoints of strategy continuum that is *the prospectors* and *the defenders* (Bentley et al., 2013). The business strategy will influence many important decision-making in product, operation, marketing and other management process. Then these actions obviously would influence the business risk. Align with the change of business risk, the top management can adjust their investment decisions. Research and Development (hereafter abbreviated as R&D) are one of the major investment areas. R&D expenditures relate to how large of budget sources spends on the innovation and technology development. These questions matter for the firm's future competitive advantage and continuously growth (Ettlie, 1998). The prospectors' features include more innovation, flexible management, decentralized control system, lower hierarchical organization structure, etc. But the defenders are opposite to the prospectors. This research follows with Miles and Snow (1978, 2003) method, a variable *STRATEGY* composite index is calculated after considering six-dimensions financial indicators. The higher *STRATEGY* scores mean the firms are applying on the prospector's strategy and the lower *STRATEGY* scores mean the firms are using the defender's strategy. To invent new products or services by the firms is to increase the competitive advantage in the industry. The firms have their internal demand to increase spending on R&D for their long-term interests. Moreover, the firms that belong to the high-technology firms can be granted the subsidies by the government. Brown and Krull (2008) find that R&D tax credit accompanying with stock option increases myopic R&D spending. In general, the research finds that there is a positive association between the business strategy and R&D expenditure. In the regression analysis, this result is robustness when the R&D expenditure is measured by different methods. This research shows that under all three strategy typologies: defenders, analyzers and prospectors, there are significant relationship between business strategy and R&D expenditure. The paper investigates the relationship between strategy and R&D expenditures in much details. This research finds the different effects on the R&D expenditures under different level of strategy scores. When the strategy is the defenders (lower level of strategy scores) or the analyzers (medium level of strategy scores), the positive relationship still exists; when the strategy is the prospectors (higher level of strategy scores), however, there is a negative relationship. The reason that a negative relationship between the prospectors strategy and R&D expenditures is that under more aggressive management policies, the firms would be more willing to invest in areas that can increase the profits in the short run rather than to

invest in R&D expenditure that benefits for maximization shareholders wealth in the long run.

In the further analysis section, this research tests whether the firm's features would influence the association between strategy and R&D expenditures. It finds that under state-owned enterprises (*SOEs*), the strategies are positively associated with R&D expenditures. However, no such effect is found under non state-owned enterprises (*Non-SOE*). Next, the research assesses the association between business strategy and R&D expenditures with different internal control quality (*ICQ*). It shows that the relationship still exists when the firms have medium or higher level of ICQ.

The paper uses the instrument variable (IV) method to solve the potential endogeneity problems because there could be some other variables also influence the dependent variable R&D expenditure (***R&D_Exp***) besides the testable variable *STRATEGY*. The social trustiness (*Trust_1st*) is selected as the IV variable because the variable *Trust_1st* is highly associated with the variable *STRATEGY* and no evidence to prove that there is a relationship between *Trust_1st* and *R&D_Exp*. Furthermore, this research finds that the fitted value (yhat) from the regression of the variable *STRATEGY* and IV variable (*Trust_1st*) is significantly related with R&D expenditures. This result convinces that the business strategy is positively related with R&D expenditures. This conclusion is robustness.

The remainder parts of this paper are organized as follows: Part 2 summaries the theory on business strategy and R&D expenditures. Then, the research hypothesis is developed; Part 3 shows the research design and the definition of dependent variables and independent variables in data management; Part 4 focuses on the research descriptive analysis and correlation matrix and regression results; In the last part, conclusions are drawn and further potential research is suggested.

2. Theory and Hypotheses Development

2.1 Theory of Business Strategy

A business strategy is a series of decision making to make the company's plan align with its environments and to design its internal rules and policies (Hambrick, 1983). There are some different classifications about the business strategy. For example, Porter (1980) describes that the business strategy typology can be cost leadership or product differentiation. The firms applying for cost leadership try to reduce the production and operating cost and further improve their competitive advantages with their more efficiency management. While, the other firms for the product differentiation strategy would invent new products and focus on a niche market with more innovation premium. Business strategy can also be classified into exploitative and explorative (March, 1991). Similarly, the strategy typology can be operational excellence, product leadership and customer intimacy (Treacy and Wiersema, 1995). This research is mainly based on the Miles and Snow (1978) strategy typology, that the strategy can be prospectors, defenders, analyzers and reactors. The Miles and Snow's strategy typology can be measured by the accounting information. That is the reason that Miles and Snow's method is selected. Following the prior research method, this research only uses three viable strategies: (1) defenders (2) analyzers (3) prospectors that they exist alone a continuum. The defender's strategy is on one end, the prospector's strategy is on another end.

The defenders strive for a stable operation process that maintaining a limited mix of products and services. These firms are likely to improve the efficiency in the production and distribution channel rather than to invest in new technology or services. How to produce and distribute products or services in a highly cost-efficient way is the key issue for the defenders' success. The financial performance of the defenders is based on its narrow and slowly growth market. The characteristics of the defenders include less innovation, standardized management, centralized control system, high hierarchical organization, etc. The defender's main risk is inefficiency and ineffectiveness as desired when the market environment changes.

The prospectors react with their environments in a way that is nearly opposite to the defenders. The prospectors emphasize on the exploitation of new products and services. These firms keep more flexible not only in responding to the change of markets but also in their internal organizational operations. The organization structure of the prospectors is more decentralized than the one of the defenders. The features of the prospectors are including lower level of formalization, dynamic communication channels and decentralized management control and planning. Therefore, the uncertainty of environments and the complexity of the operation process would increase when the firms have applied for the prospector's strategy.

The different strategies lead to a variety of business risks that the firms involve in. Naviss et al. (2017) find that the prospectors are willing to over-invest because more stock-based compensation in the prospectors would make the management invest even negative NPV projects. At the same time, the more uncertain in the prospectors gives the more discretionary in the decision-making process. On the contrary, the compensation is much based on cash payment in the defenders. The defenders ignore the new technology development to reduce the business risk and

make the firm focus on operational efficiency improvement. Therefore, the defenders are more willing to under-investment. What's more, business strategy also matters for the financial reporting irregularities. Bentley et al. (2013) finds that the prospectors have more chances to experience financial reporting irregularities and to have higher audit fees compared with the defenders. Moreover, the prospectors are also more likely than the defenders to have going concerns opinions and material weakness opinions that issued by the auditors. It is found that the prospectors have more motivation in tax-avoidance than the defenders. The prospectors expect heavily tax-planning chances and engage in more tax aggressive (Higgins, et al., 2015).

2.2 Research on R&D Expenditures

Research and development (R&D) expenditures are a key indicator for measuring a firm's innovation input. What's kind of level spending in R&D relates to the firm's competitive advantage and continuously development (Ettlie, 1998). Bushee (1998) believes that R&D expenditures can be manipulated by the management. There are two opposite viewpoints for understanding the real earning management. First, the firms are more likely to reduce the R&D expenditures on the purposes of increasing the short-term financial performance. Such kinds of myopic behavior could happen when the CEO is to retire soon, or the firm has much performance benchmarking pressure (Dechow and Sloan 1991, Baber et al. 1991). It is also found that the firms can benefit from tax credit of the R&D expenditures. That means R&D tax credit motivates the management to spend more in R&D expenditures (Brown and Krull, 2008). Does any other factor exist for determining the R&D expenditures? This research tries to fill in the gap.

2.3 Hypothesis Development

The business strategy is the firms' long-term plan to determine the areas where the firms should allocate the more sources in. The business strategy can include any plan about the new product design, new market exploration, new technology development, new operating processes, etc. The business strategy can range from the defenders, analyzers and prospectors according to the ranking of strategy scores. Higher strategy scores mean the firms put more sources into the research and development, market expansion and capital assets allocation. Normally, the more prospector's strategies, the more rapid growth of sales revenues and market shares. In the competitive market, the prospector firms must occupy larger market shares with its new design products or its new operating process as soon as possible, otherwise the new entry firms would mimic the similar strategies and products. Therefore, the prospector's strategies would continuously increase the investment on new technologies' research and development in order to get the extra competitive profit premium. In the modern economies' regime, the main growth force is driven by the innovation on the technology and business process. The life cycle theory indicates that the product or industry can be classified into several stages in its whole life cycle: the beginning period, the growth period, the mature period and the decline period. The prospectors always are in the stage of beginning period and the growth period. The features in the beginning and growth stages are high percentage expenditures on products development and market expansion. In China, there are different levels of government subsidies on high-technology industries. More research and development spending also mean much more uncertainty in future. The government subsidies can encourage the firms to invest in research and development and offset some risks that arising from the R&D investment. So the more that the firms increase the R&D expenditures, the more the firms can receive the subsidies from the government. These are the motivation for the firms to enlarge the R&D expenditures. Therefore, this research makes the following hypothesis:

Hypothesis: the firms' business strategy is positively associated with the expenditures on research and development.

$$R\&D_{it} = \alpha_0 + \alpha_1 STRATEGY_{it} + \alpha_2 Size_{it} + + \alpha_3 ROA_{it} + \alpha_4 Leverage_{it} + \alpha_5 Firm\_Age_{it} + \alpha_6 Industry\_FE + \alpha_7 Year\_FE + \varepsilon \quad \text{(Model 1)}$$

Second, this paper emphasizes the research in China. After the many years high growth in economies, many China's industries are very competitive in the market. With the industry competitive pressure, the firms, especially the prospectors, apply for much more short-term oriented investment. So, in extreme case, there would be market-driven rather than innovation driven strategies. This research assumes that in extreme higher strategy scores, the firms could reduce the R&D expenditures and transfer to market expansion on the purpose of targeting the performance threshold.

Furthermore, many listed firms in China are state-owned enterprises (SOEs). In these SOEs, the management processes are quite standardized and supervised by better corporate governance. This research assumes that the relationship between the business strategies and the R&D expenditures is stronger in SOEs than in non-SOEs.

Finally, the internal control quality matters for the firms' earning management. The earning management consists of the accrual earning management and real earning management. The R&D expenditures can be manipulated by the management to meet the myopic purposes. This kind of real earning management can be reduced by improving internal control quality. This paper assumes that the positive association between the strategies and the R&D expenditures is more significant in better internal control quality firms.

3. Research Design and Measurement of the Main Variables

3.1 Dependent Variable

R&D_Exp represents the R&D expenditures. The measurement of the *R&D_Exp* is followed as the research method of scaled discretionary expenditures which is used by Cohen et al. (2008) and Roychowdhury (2006). The fitted value (yhat) of the following regression model is the proxy of R&D expenditures (*R&D_Exp*).

$$\frac{R\&D_{i,t}}{A_{i,t-1}} = \alpha_0 + \frac{\alpha_1}{A_{i,t-1}} + \alpha_2 \frac{SALES_{i,t-1}}{A_{i,t-1}} + \mu_{i,t} \quad \text{(Model 2)}$$

R&D_Apply is an alternative variable of R&D expenditures. The data is originated from CSMAR database in China. R&D_Apply is the total sum of the numbers of patent application, invention application, utility application and design application.

Patent_Apply is the number of patent that the firms apply for in the industry-year. Patent application is a component of R&D_Apply.

3.2 Independent Variable

The business strategy is measured by the methods of Miles and Snow (1978, 2003) and Bentley et al. (2013) and Higgins et al. (2015). The variable *STRATEGY* is a composite index that uses six different dimensions to reflect the firms' business strategy. The six dimensions are as follows: (1) *RDS* shows the level of the firm's pursuit of new products or services. It equals to the research and development expenses divided by the total sales revenues. (2) *EMPS* demonstrates the operating efficiency. It is the number of employees divided by the total sales revenues. (3) *REV* means the growth of the firms' sale revenues. (4) *SGA* means the level of spending expense in marketing and administration. It is the total selling and administration expenses divided by the total sales revenues. (5) *CAP* means the capital intensiveness. It equals to the fixed assets (PPE) divided the total assets. (6) *EMPF* measures the stability of the firm's employees. It is the standard deviation of the number of the firm's employees. Each dimension measure with a rolling 5-year average. Each dimension will be assigned with the number from 1 to 5 after considering the industry and year effect. In every industry-year, the research scores the observations 5 for the first quintle, then makes the observations 4 for the next quintle, and so on. Those in the lowest quintile get the score of 1. Therefore, the range of the variable *STRATEGY* is from 6 to 30 after accumulating the six dimensions scores. The higher score of *STRATEGY* means more aggressive strategy that the firm applies. The paper follows the similar classification of *STRATEGY* from Bentley et al. (2013) and Higgins et al.(2015) and Wang et al.(2016), when the *STRATEGY* score that is less than 16, the firm applies for the defenders strategy; when the *STRATEGY* is between 16 to 22, the firm belongs to the analyzers; when the *STRATEGY* is from 22 to 24, the firm is the prospectors.

This paper includes the following control variables in the regression model. *Size* is to measure the firm's size that is the natural logarithm of total assets. *ROA* is to assess the efficiency and profitability of the firms and is equal to the net income divided by the total assets. *Leverage* is to show the financial debts scaled by the total assets. *Firm_Age* is the natural logarithm of the firm's age. Moreover, the paper also controls the industry effect (*Industry*) and Year effect (*Year*).

4. Main Empirical Results

4.1 Descriptive Data and Correlation Analysis

All financial data are selected from CSMAR database in China. The trustiness data is from the research of Wang et al. (2013). This research time period is from 2008 and 2012.

4.1.1 Descriptive Analysis

The data descriptive summaries the variables' features. For the dependent variable *R&D_Exp*, the average mean is 0.94, however, the maximum value reaches to 406.99. It fits for the higher standard deviation (13.33). These information shows the input of R&D varies a lot from each firm. The independent variable *STRATEGY* ranges from 6 to 30. Its mean is 19.05. Its standard deviation is 4.51.

Table 1. Date summary

Variable	**Mean**	**Std. Dev.**	**Min**	**Max**
R&D_Exp	0.94	13.33	-2.35	406.99
STRATEGY	19.05	4.51	6.00	30.00
Size	21.53	1.24	16.70	28.86
ROA	0.06	0.38	-6.76	20.79
Leverage	0.43	1.73	0.00	96.96
Firm_Age	11.22	5.10	0.00	34.00

4.1.2 Correlation Analysis

This research first calculates the correlation matrix in order to show the relationship between every two variables. The coefficient of correlation between *STRATEGY* and *R&D_Exp* is 0.120. It means there is a positive relationship between *STRATEGY* and *R&D_Exp*. This is aligned with the previous assumption.

Table 2. Correlation matrix

	R&D_Exp	STRATEGY	Size	ROA	Leverage	Firm_Age
R&D_Exp	1					
STRATEGY	0.120	1				
Size	-0.036	-0.272	1			
ROA	0.008	0.043	-0.023	1		
Leverage	-0.017	-0.038	-0.053	-0.227	1	
Firm_Age	-0.039	-0.175	0.241	-0.007	0.067	1

4.2 Multivariate Regression Analysis

4.2.1 Business Strategy and Research and Development Expenditures

The relationship between strategy and R&D expenditures is shown in table 3. The table 3 measures the regression results of business strategy (*STRATEGY*) on R&D expenditures (*R&D_Exp*) and the strategy on patent and invention application (*R&D_Apply*). In column (1), the coefficient on STRATEGY is positive at the level of significant 1% (p<0.01). It indicates that the firms with higher business strategy scores would expend more on research and development. Similarly, in column (2), the coefficient on *STRATEGY* is also positive and significant (p<0.01). The patent application (*R&D_Apply*) is an alternative variable of R&D expenditures (*R&D_Exp*). Both results support the hypothesis that higher strategy scores in firms will invest more on research and development.

Table 3. Regression of business strategy on R&D expenditures and patent application over 2008-2012

	(1)	(2)
VARIABLES	*R&D_Exp*	*R&D_Apply*
STRATEGY	0.329***	0.0202***
	(0.0593)	(0.00510)
Size	0.492*	0.437***
	(0.270)	(0.0264)
ROA	0.0622	0.0103
	(0.503)	(0.0386)
Leverage	0.0153	0.000979
	(0.125)	(0.0102)
Firm_Age	-0.00314	-0.0211***

	(0.0608)	(0.00654)
Year	Yes	Yes
Industry	Yes	Yes
Constant	-17.93***	-7.882***
	(6.642)	(0.648)
No. of Observations	3,442	3,561
Number of ID	1,238	1,246

Standard errors in parentheses

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

Note: Each ***R&D_Exp*** variable has already multiplied by 1000 in order to enlarge the effect in the test and the ***R&D_Apply*** variable is already taken the logarithm in each variable

4.2.2 Non-linear Relationship Between Business Strategy and Research and Development Expenditure

To investigate the detail relationship between business strategy and R&D expenditures, this research classifies the business strategies into three types: *Defenders*, *Analysers* and *Prospectors* according to the organizational theory (Miles and Snow, 1978, 2003). Defenders strategy firms are any firms that their strategy scores are less than 16; Analysers strategy firms' scores are between 16 and 22, while the scores between 22 and 24 fit for the prospectors strategy firms (note 1).The Table 4 describes the different results about the relationship between the business strategy (*STRATEGY*) and patent application (*R&D_Apply*) after controlling the firms' size(*Size*), firm's efficiency and profitability (*ROA*), firms' debt(*Leverage*) and firms' age (*Firm_Age*) (Note 2).In column (1), the coefficient for *STRATEGY* is positive and significant (*p<0.05*). The coefficient for *STRATEGY* is 0.0438. In column (2), the coefficient for STRATEGY is 0.0459 at the significant level of 5% ($p<0.05$). In column (3), the coefficient for STRATEGY is -0.395 at the significant level of 1% ($p<0.01$). These regression results show that there is a positive relationship between business strategy and R&D expenditure when the strategy scores are at the lower or medium levels. In the higher level of strategy scores, more prospectors firms seem to reduce the investment in research and development. The prospector firms wish to expand the market size and increase the sales in short run under higher uncertain situation. Under the prospector strategy (higher strategy scores) stages, whether the firms have enough financial resources is a key issue. The management is motivated to cut R&D expenditures to increase the short-term earnings goals (Bushee, 1998; Dechow and Sloan, 1991; Jacobs, 1991). At this specific condition, it is possible to make less R&D (*Patent_Apply*) investment in this ambiguity business stage.

Table 4. Regression of business strategy on the variable patent apply with different level of strategy scores

	(1)	(2)	(3)
VARIABLES	*Patent_Apply* ***Defenders Strategy STR<16***	*Patent_Apply* ***Analyzers Strategy 16<STR<22***	*Patent_Apply* ***Prospectors Strategy 22<STR<24***
STRATEGY	0.0438**	0.0459**	-0.395***
	(0.0203)	(0.0182)	(0.121)
Size	0.519***	0.531***	0.453***
	(0.0453)	(0.0372)	(0.125)
ROA	0.716	0.102*	1.502
	(0.600)	(0.0554)	(1.471)
Leverage	-0.0284	0.113**	1.716***
	(0.0872)	(0.0487)	(0.606)
Firm_Age	0.00198	-0.0142*	-0.0298
	(0.0119)	(0.00855)	(0.0193)

Year	Yes	Yes	Yes
Industry	Yes	Yes	Yes
	(1.118)	(0.949)	
No. of Observations	911	1,490	195
Number of ID	452	818	171

Standard errors in parentheses

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

5. Further Analysis

5.1 SOEs vs. Non-SOEs

This research finds the relationship between business strategy and R&D expenditures under different types of firms: SOEs (State of Enterprises) and non-SOEs (non-State of Enterprises). In column (1) of Table 5, it shows the regression result within SOEs. The coefficient of *STRATEGY* is positive and significant (p<0.01). However, in column (2), for these non-SOEs, there is no significant relationship between business strategy and R&D expenditures. In China, to build more innovative and core competence firms are encouraged by the national policies. The performance of SOEs is evaluated by the governments. The SOEs can be influenced by these industry policies more significantly than the non-SOEs. Although there is much uncertainty in R&D investment, the SOEs still increase their innovative inputs in R&Ds on the purposes of continuous development for the firms.

Table 5. Regression of business strategy on R&D expenditures under the SOE and Non-SOE background

	(1)	(2)
VARIABLES	*R&D_Exp*	*R&D_Exp*
	SOE	***Non-SOE***
STRATEGY	0.270***	0.0842
	(0.0693)	(0.0525)
Size	0.372	0.421
	(0.295)	(0.324)
ROA	0.0246	0.0279
	(0.179)	(0.315)
Leverage	0.0130	-0.00225
	(0.0705)	(0.0782)
Firm_Age	-0.190*	-0.000931
	(0.0977)	(0.0780)
Year	Yes	Yes
Industry	Yes	Yes
	(7.297)	(7.811)
No. of Observations	2,400	2,854
Number of ID	595	995

Standard errors in parentheses

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

(Note: Each ***R&D Expenditures*** variable has already multiplied by 1000 in order to enlarge the effect in the test)

5.2 Internal Control Quality

Internal control is a series of firm's policies and regulations to assure the achievement of the firm's objectives. According to U.S. COSO internal control framework, the internal control framework has 5 components, that are

control environment, risk assessment, control activities, communication and monitoring (Arens, et al., pp281-295). The data of measuring internal control quality originates from the DIB internal control index which is published annually based the firm DIB firm in China. The internal control quality (ICQ) is the composite index based on the considering the 5 components of internal control. This research wishes to observe the relationship between STRATEGY and R&D expenditure under different internal control quality. Any ICQ less than 25 percentiles belongs to the low-level ICQ, while, the ICQ between 25 percentiles and 75 percentiles is the medium-level ICQ and the ICQ between 75 percentiles and 90 percentiles means the high-level ICQ. Table 6 shows the regression of business strategy on R&D Expenditures with different levels of internal control quality (ICQ). Similar as the research Lu et al. (2015), the internal control quality is classified into 3 level that is low, medium and high level. In column (1), the internal control quality indicator is less than 540.97 which is 25 percentiles in the internal control quality (ICQ) index. This column shows the regression of STRATEGY on R&D expenditures within the firms that have lower internal control quality. In column (2), the ICQ is between 540.97 and 711.5, in other words, the ICQ is between the 25 percentile and 75 percentile which means medium level of internal control quality index. In column (3), the internal control quality index is between 75 percentile (711.5) and 90 percentiles (750.63) (Note 3). This column summaries the regression of *STRATEGY* on R&D expenditures for the higher level of ICQ index. In column (2) and (3), the regression results mean that the relationship between business strategy and R&D expenditures are positive and significant ($p<0.01$ and $p<0.05$ respectively). However, in column (1), there is no such significant relationship. All these regression results mean the higher business strategy index of the firms can lead to higher R&D investments on the condition that the firms have better internal control quality. If the firms' internal control quality is worse, the management teams would make decisions on the interests of themselves rather than the maximization of shareholders wealth. These myopic R&D investments decision would not be influenced by the different levels of business strategy scores.

Table 6. Regression of business strategy on R&D expenditures under the different level of ICQ

	(1)	(2)	(3)
VARIABLES	*R&D Expenditures* ***Lower ICQ*** *ICQ<540.97*	*R&D Expenditures* ***Medium ICQ*** *540.97<ICQ<711.5*	*R&D Expenditures* ***Higher ICQ*** *711.5<ICQ<750.63*
STRATEGY	0.0893	0.289***	0.234**
	(0.0563)	(0.0542)	(0.0980)
Size	0.108	0.788**	0.0177
	(0.284)	(0.307)	(0.526)
ROA	-0.0190	1.312	5.682
	(0.0504)	(3.101)	(8.738)
Leverage	0.000474	-1.682	0.388
	(0.0221)	(1.306)	(2.708)
Firm_Age	-0.203	-0.0153	-0.0368
	(0.247)	(0.0529)	(0.0932)
Year	Yes	Yes	Yes
Industry	Yes	Yes	Yes
Constant	-2.663	-23.59***	-4.798
	(14.23)	(6.860)	(11.79)
No. of Observations	724	3,050	909
Number of ID	409	1,235	609

Standard errors in parentheses

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

Note: Each ***R&D Expenditures*** variable has already multiplied by 1000 in order to enlarge the effect in the test

6. Endogeneity Test

6.1 Selection of Instrument Variable

On the purpose of solving the possible endogeneity problems, the IVs method is applied. First, the selection of instrument variable is the key issue. This research chooses the 1st rank of trustiness (*Trust_1st*) in China as the instrument variable. The data of 1st rank of trustiness originates from the research of Wang et al. (2013). Trust could be a good corporation governance indicator. The trustiness is much related with business strategy. In the region of more trustiness, people can communicate very well and share more information and reduce the information asymmetric problems. The information asymmetric issue matters for the business strategy (Bentley et al., 2013). At the same time, there is no research to mention that the strong relationship between trustiness and R&D expenditures. In short, the variable *Trust_1st* being selected as an instrument variable is suitable.

6.2 Instrument Variable (IV) Test Result

Table 7 measures the regression of IV variable *Trust_1st* on R&D expenditures. In column (1), the regression shows that the IV variable *Trust_1st* is positively and significantly (*p<0.01*) associated with *STRATEGY*. Then the fitted value (yhat) is found and selected with the alternative variable of *STRATEGY* after the regression analysis. The fitted value (yhat) is defined as *STRATEGY_IV*. In column (2), the regression shows the *STRATEGY_IV* has positive and significant (*p<0.01*) relationship with R&D expenditures. This means that the hypothesis that more business strategy is associated with higher R&D investments is proved after considering the endogeneity problems.

Table 7. Regression of the variable ***Trust_1st*** on business and the instrument variable of strategy on R&D Expenditures

	(1)	(2)
VARIABLES	*STRATEGY*	*R&D Expenditures*
STRATEGY_IV		3.124***
		(1.150)
Trust_1st	0.0431***	
	(0.0158)	
Size	-0.448***	1.505***
	(0.0621)	(0.545)
ROA	-0.150***	0.441**
	(0.0461)	(0.202)
Leverage	-0.0350**	0.107*
	(0.0162)	(0.0563)
Firm_Age	-0.114***	0.310**
	(0.0185)	(0.147)
Year	Yes	Yes
Industry	Yes	Yes
Constant	28.06***	-91.75***
	(1.516)	(32.79)
No. of Observations	5,405	5,140
Number of ID	1,503	1,489

Standard errors in parentheses

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

Note: Each ***R&D Expenditures*** variable has already multiplied by 1000 in order to enlarge the effect in the test

7. Conclusions

This paper highlights the positive relationship between business strategy and R&D expenditure. The result is robustness when the R&D expenditure is measured with different methods. However, it is found that under extreme case (the prospector's strategy), the management myopic behaviour would allow the firm to invest in more profitable projects rather than in research and development. Then there is a negative relationship under such situation. The research also testifies that the similar relationship exists when the firms are SOEs and the firms have medium or higher level of internal control quality (ICQ). Finally, in order to solve for the endogeneity problems, the instrument variable (*IV*) method is applied. The variable *Trust_1st* is selected as the *IV* variable. The fitted value (yhat) originated from the regression between *STRATEGY* and *Trust_1st* is tested to have a significant relationship with R&D expenditure. This result proves the desired hypothesis.

There are some drawbacks in this paper. One, business strategy is measured by a composite index. The variable *STRATEGY* may not reflect the firm's strategy accurately. Second, the paper's conclusion is got from the listed firms, however, it is still not known whether the relationship exists when considering the entrepreneurs companies or not-listed companies. It is suggested that the researcher can switch to these companies in future.

Acknowledgements

1. The prospector's strategy firms are not covering the scores more than 24. The reason is to reduce the extreme value effect.

2. This research has also tested the relationship between *STRATEGY* and *R&D_Exp* under different level of strategy typology. No significant relationship is found. The reason could be smaller sample size when business strategy divides into three different typologies.

3. This research ignores any internal control quality (ICQ) index that is larger than 750.63 in order to reduce the extreme value effect.

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