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R&D spending, strategic position and firm performance

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Abstract

Based on R&D investment data from Chinese listed manufacturing firms, this paper examines the effect of R&D spending on firms' future performance conditional on their strategic positions. We find that firms pursing a product differentiation strategy have more R&D spending than those with a cost leadership strategy. In addition, we document a positive effect of R&D spending on firms' future performance if they adopt a product differentiation strategy. Meanwhile, for the firms that adopt a cost leadership strategy, the relationship between R&D spending and firm performance resembles an inversed U-shape. Furthermore, we find this inversed U-shape relationship only exists for non-state-owned firms. Overall, this paper provides guidance and useful suggestions on the efficient allocation of R&D resources for Chinese manufacturing firms.

Keywords: R&D spending, Strategic position, Firm performance

Introduction

Technological innovation is the main driving force of economic growth. As one important channel to generate new technology, the intensity of research and development (R&D) spending is found to be positively associated with firm operating performance and market valuation (Branch 1974; Chauvin and Hirschey 1993; Sougiannis 1994; Eberhart et al. 2004; Armstrong et al. 2006). However, R&D is also associated with risk. Chan et al. (2001) find that R&D intensity is positively associated with return volatility, while Shi (2003) argues that R&D risk dominates their benefits. The optimal level of R&D spending has always been questioned, and becomes even more complicated when the effect of R&D spending varies with firms' own characteristics (Chan et al. 1990; Eberhart et al. 2004).

In this paper, we examine the relationship between R&D spending and firm performance conditional on corporate strategic positions. Rather than focusing on external objective conditions, we emphasize the role that managers' subjective initiative plays on the effect of R&D spending on firm performance. We follow Porter's (1980) generic strategies to classify firms into ones adopting a product differentiation strategy and ones with a cost leadership strategy. We first find that firms with a product differentiation strategy have more R&D spending than ones with a cost leadership strategy. Furthermore, we find that the relationship between R&D spending and firm performance is different for these two types of firms. R&D spending is positively associated with future performance for the firms that adopt a differentiation strategy, but the relationship becomes an inversed U-shape for the firms that adopt a cost leadership strategy. Finally, we find that the relationship between R&D spending and firm performance only exists for non-state-owned firms (non-SOEs).

Our classification of firms along the dimension of their strategic strength is closely related to the intensity of R&D expenditures by nature. We argue that only when the level of R&D spending is consistent with a firm's particular competitive advantage, the effectiveness of R&D spending is maximized. Different strategic positions offer different competitive advantages. For firms that adopt a product differentiation strategy, their advantage is their uniqueness, which has to be backed up by continuous extensive research. They require a large amount of R&D spending to differentiate themselves from other competitors and resist the negative effects of technological spillover. Due to innovations generated from R&D, these firms can command higher prices for their valued products or services and thus guarantee future earnings. Therefore, we argue that R&D spending is higher for firms with a product differentiation strategy, and that R&D spending has future positive effects on firm performance.

The case is different for firms with a cost leadership strategy. The core competitive advantage of these firms is efficiency. Maintaining tight cost controls, these firms aim to defeat other competitors via aggressive pricing and maximizing economic scale. For this type of firm, spending on R&D is necessary to help design products for ease of manufacturing and the optimization of production procedures. However, excessive R&D spending violates the principle of strict cost control and may impose unnecessary financial burdens. In addition, too much innovation that cannot be translated into large-scale production would also be a waste of resources. We argue that firms with a cost leadership strategy can have lower levels of R&D spending, and that only an appropriate level of R&D spending has a positive impact on future performance.

The empirical results are consistent with our arguments. Using 1506 Chinese manufacturing firms listed on the Shanghai and Shenzhen stock exchanges and the Growth Enterprise Market (GEM) Board from 2009 to 2016, we first classify firms as either following a product differentiation strategy or a cost leadership strategy according to their operating profit margin and asset turnover. We also show that the strategy adopted by any particular firm is persistent over time. About 70% to 80% of firms adopt the same strategy as they adopted in the previous year. Based on this classification, we use the percentage of R&D spending to operating income as the measure of R&D intensity and find that the R&D (%) mean is 3.899 for the firms with a product differentiation strategy and 2.534 for the ones with a cost leadership strategy. The higher levels of R&D spending for firms with a product differentiation strategy is also documented in the regression analysis.

Furthermore, we use three-years forward *ROA*, *ROE* and *TOBINQ* as the measurements for future performance, and find that R&D spending has a positive effect on all three measurements for the firms that adopt a product differentiation strategy. Meanwhile, for firms with a cost leadership strategy, we find an inversed U-shape relationship between R&D spending and two of the three measurements. The result of *TOBINQ* is insignificant given the inefficiency of the Chinese stock market. In addition, we find that most of the cost-leadership-strategy firms do not exceed the threshold for appropriate R&D spending. Finally, the relationship between R&D spending and future performance only exists for non-SOE firms. We argue that for state-owned firms that have multiple objectives when screening R&D projects, the investment efficiency of R&D is distorted in terms of economic benefit.

Our paper makes three contributions. First, we reexamine the effect of R&D spending on future performance from the new perspective of a firm's particular strategy. We emphasize that the intensity of R&D spending should be consistent with the aims and overall plan of a particular firm, and that excessive R&D spending could sometimes have a negative impact on future performance. Second, our paper adds to the literature on firms' strategic positions by providing a special application of Porter's (1980) generic strategies to R&D spending. Our paper highlights that a better understanding of firms' strategic positions could also help managers find a balance between budgets and efficient investment, which helps maximize economic performance. Finally, we make practical suggestions on how to allocate R&D resources efficiently especially for Chinese manufacturing firms.

The paper proceeds as follows. In the next section, we review the literature and develop our hypotheses. Section "Measurement of variables and research design" describes measurements of variables and research design. Section "Empirical results" reports the empirical results and section "Conclusions" concludes.

Literature review and hypothesis development

The effect of R&D spending on firms' future performance is widely studied in the literature. However, whether R&D expenditure can really improve earnings and valuation and the extent of its impact is still under debate. On the one hand, R&D investment can trigger technical innovations that boost firms' development. There is considerable evidence that R&D activity tends to increase firms' future profitability (Branch 1974; Sougiannis 1994; Eberhart et al. 2004), has a positive impact on a firm's market value (Chauvin and Hirschey 1993; Sougiannis 1994; Armstrong et al. 2006) and earns excess stock returns (Lev and Sougiannis 1996; Chan et al. 2001). On the other hand, the costs of R&D spending has also been attracting more and more attention. The trade-off between R&D benefits and costs is more challenging than previously thought and in some circumstances it has been demonstrated that the risk of investment failure even outweighs the benefits (Shi 2003). R&D intensity has also been found to be positively associated with return volatility by Chan et al. (2001).

Great efforts have been made to examine how the benefits and costs of R&D activity can be balanced based on mixed evidence from previous studies. One of the breakthroughs is to examine how the impact of R&D activity varies across industries. For example, although the share-price responses to announcements of increased R&D spending are significantly positive on average, Chan et al. (1990) find conflicting evidence for high- and low-technology firms. High-technology firms that announce increases in R&D spending are associated with positive abnormal returns, whereas announcements by low-technology firms experience negative abnormal returns. In addition, Eberhart et al. (2004) also find that high-tech firms have better abnormal operating performance after unexpected increases in R&D expenditure than low-tech firms. Furthermore, the positive impact of R&D only exists for certain kinds of industries, such as internet and biotech firms (Garner et al. 2002). This line of literature raises the possibility that there is actually no one-size-fits-all principle for optimal R&D

spending. Overlooking the interactive process between R&D activity and the firms' inter- and outer- environment may be one reason for this debate.

In the literature, little evidence has been provided for the varying impacts of R&D activity at the firm level. Our paper fills this gap by making the further analysis of R&D impact conditional on the core of corporate finance—a firm's own business strategy, rather than a generalized analysis focusing on one particular industry. In fact, firms within the same industry also adopt different strategies that add to the confusion. Our analysis fills in some of the gaps in industry-level studies. More importantly, instead of focusing on external objective conditions, we emphasize the role that managers' subjective initiative plays on the effect of R&D spending. For example, McGrath and Nerkar (2004) find that firms' propensity to invest in new R&D options is influenced by the scope of opportunity, prior experience, and competitive effects. Meanwhile, our analysis links R&D activity to the key factor of internal operations and emphasizes the compatibility between managers' R&D investment decisions and a firm's overall business strategy. The superiority of using the decision maker's internal incentives as a starting point lies in that it can highlight the dynamic feedback process of R&D activity and future performance. It implies that managers should act to adjust the level of R&D spending based on their firm's strategic position rather than be constrained by external conditions.

We use Porter's (1980) generic strategies to categorize firms according to their competitive advantages. The generic strategies are the basis on which a firm may seek to achieve a lasting position in its environment. Porter (1980, 1996) develops a conceptual typology of three generic competitive strategies along the dimensions of strategic scope and strategic strength. In this paper, we focus on the supply-side dimension and look at the strengths and core competitive advantages of a firm. The strategy of differentiation aims at creating unique products or services which attract brand loyalty and price inelasticity. This strategy must be backed up with costly activities such as product design, marketing expenditures and especially, extensive research. Meanwhile, the strategy of cost leadership aims to build market share via aggressive pricing to maximize economies of scale, which requires tight cost controls. It involves the "construction of efficient-scale facilities, rigorous pursuit of cost reductions from experience, tight cost and overhead control, avoidance of marginal customer accounts, and cost minimization in areas like R&D, service, sales force, advertising, and so on" (Porter 1980). Due to resource restrictions, firms cannot deploy both strategies simultaneously. In his analysis of capital goods producers, Hambrick and Mason (1984) finds only clusters for one single strategic position. His argument is consistent with Porter's (1980) view that firms avoid a "stuck in the middle" position.

We first explore whether the level of R&D spending is different, conditional on different strategic positions. According to the aims of a product differentiation strategy, the uniqueness of a product or service requires extensive spending on R&D, which is necessary to maintain its competitive advantage and provide higher sales margins. In addition, a continuous flow of new products as well as R&D expenditures is also needed to minimize the effect of technology spillover (Los and Verspagen 2000). In comparison, the focus of a cost leadership strategy is devoted to cost control. R&D spending and product innovation are not core competitive advantages, and they are usually tightly controlled to minimize cost. Following these arguments, we obtain the first hypothesis as follows.

H1: There is more R&D spending by firms adopting a product differentiation strategy than the ones adopting a cost leadership strategy.

Turning to the relationship between R&D spending and firm performance, we argue that the effect of R&D spending depends on a firm's particular strategic position. To maximize profit, the level of R&D spending should match up with a firm's aim and strategy. For the differentiation strategy, as its aim is to provide unique products and services, continuous innovation is critical for a firm to differentiate itself from low cost producers and imitations. This argument is consistent with previous industry-level analysis that the R&D spending of high-tech firms which are more likely to adopt a differentiation strategy, is a critical determinant of a firm's performance (Chan et al. 1990; Garner et al. 2002). We posit that R&D spending helps improve performance for firms pursing a product differentiation strategy.

H2: If firms adopt a product differentiation strategy, R&D spending would have a positive effect on their future performance.

The core competency of cost leadership is efficiency, while proper R&D spending is necessary to improve efficiency. It can help to design products for ease of manufacturing, recuse product material cost, and optimize producing procedures, which entail the use of large-scale facilities and systems that constitute barriers to entry. However, too much R&D spending is against the principle of cost leadership. Firstly, it conflicts with the strategy of producing lower price products by tightly controlling costs in all aspects of the business. Secondly, it is impossible for all new products invented by R&D to be manufactured on a large scale. Porter (1980) emphasizes that a cost leadership strategy should avoid "marginal customer accounts," which means too much R&D spending on special products is a waste of resources for firms adopting this strategy. We posit that successful strategic positions can improve firms' performance. That means for firms with a cost leadership strategy, the efficiency induced by proper R&D spending leads to the best performance. In addition, we argue that the feedback process from performance to investment decisions may push back the level of R&D spending when it exceeds a certain threshold. If this feedback is effective and no firm makes excess investments, we posit the relationship would display a diminishing marginal benefit instead.

H3: If firms adopt a cost leadership strategy, the relationship between R&D spending and future performance presents as an inversed U-shape. If no firm exceeds the optimal level of R&D spending, the marginal benefit of R&D spending diminishes.

The different impacts of R&D spending on future performance in turn explain why R&D spending is higher for product-differentiation-strategy adopters than cost leadership firms. As firms' future performance is positively associated with the R&D spending for product differentiation strategy, increasing R&D spending and encouraging innovation serve as efficient ways to improve future performance. This positive feedback makes managers more confident in further increasing the level of R&D spending. To the contrary, the inversed U-shape relationship between R&D spending and future performance makes cost leadership adopters more conservative about R&D spending. It is essential to balance benefits and costs, and the negative feedback of excess R&D spending can in turn decrease the level of R&D spending. As a result, the level of R&D spending will be different for different strategy adopters as stated in the first hypothesis.

Finally, we argue that the association between R&D spending and performance is different for SOEs in China. First, unlike non-SOEs that mainly focus on economic performance, SOEs have multiple goals including social and political contributions. Therefore, their choice of R&D projects is not purely based on whether an innovation would improve economic performance or not. Therefore, R&D spending may not be done with the same kinds of economic benefits as for non-SOEs in mind, thus the relationship with future performance is less established. Second, with priority for resources and government support, the performance of SOEs in China is less sensitive to R&D spending than for non-SOEs. We state our fourth hypothesis as follows.

H4: For state-owned firms, there is no relationship between R&D spending and their future performance.

Measurement of variables and research design

Identification of the strategic positions

Following Snow and Hambrick (1980), we use objective indicators to identify firms' strategic positions. Unlike other approaches that rely on the perceptions of individuals, this method controls potential perceptual biases and allows for large and heterogeneous samples. As documented by Selling and Stickney (1989), the firms adopting a product differentiation strategy aim to differentiate their product and obtain market share over revenues and profit margins, while the firms adopting a cost leadership strategy intend to obtain high profit levels by charging low prices and achieving high volumes. Therefore, the product differentiation strategy focuses on improving profit margins, while the cost leadership strategy is trying to increase asset turnover. Following their argument, we use the indicators of operating profit margin and asset turnover to identify firms' strategic positions.

Using financial ratio analysis to identify the strategic position is widely applied in the literature (Palepu and Healy 2008; Soliman 2008; Little et al. 2009). Soliman (2008) suggests that asset turnover can be used as the measure of efficient inventory processes and working capital management, while profit margin is an indicator for pricing power, such as product innovation and brand name recognition. The firm adopting cost leadership strategy may generate a relatively low profit margin but balance that with relatively high asset turnover, while a product differentiation strategy may be successful by generating high profit margins and low asset turnover (Palepu and Healy 2008).

In this paper, we classify firms into four groups according to the values of operating profit margin and asset turnover each year. We identify the group of firms with higher operating profit margins and lower asset turnover as firms that adopt a product differentiation strategy and the ones with lower operating profit margins and higher asset turnover as firms with a cost leadership strategy. The operating profit margin is measured as operating profit divided by operating income *(OPROF)*, while asset turnover is measured as operating income divided by average net fixed assets (*ATURN)*. We also argue that the strategic positions should be persistent over years. If firms change strategy, their R&D spending likely change as well.

Research design

We use simple ordinary least squares (OLS) regressions to test the hypothesis. Hypothesis 1 states that there is more R&D spending for firms that adopt a product differentiation strategy than the ones adopting a cost leadership strategy. We construct two dummy variables to test the effects of different strategies. One is *PD_Strategy*, which equals 1 if the firm adopts product differentiation and 0 otherwise. The other is *CL_Strategy*, which equals 1 if the firm adopts cost leadership and 0 otherwise. We estimate the following regression model using all observations:

$$RD(\%)_{it} = \beta_0 + \beta_1 PD\_Strategy_{i,t} + \beta_2 CL\_Strategy_{i,t} + \sum_k \gamma_k Control_{it}^k + Year + Ind + \varepsilon_{it}, \tag{1}$$

where *R&D* (%) is the percentage of R&D spending to operating income for firm *i* at year *t*, Control denotes *SIZE*, which is the log of total assets for firm *i* at year *t*, and *LEV*, which is total liabilities divided by total assets for firm *i* at year *t*, *Year* and *Ind* are year and industry dummies controlling for year and industry fixed effects. If the coefficient of *PD_Strategy* is significantly positive while *CL_Strategy* is significantly negative, the predictions of Hypothesis 1 would be strongly supported. It means compared with other strategies (dual strategies and an indistinct strategy), the firms which adopt a product differentiation strategy intend to spend more on R&D, while the firms with a cost leadership strategy intend to spend less. As we use the ratio of R&D spending to operating income instead of the total amount to measure the extent of R&D spending, we also predict the coefficient of *SIZE* to be negative given the large economic scale. In addition, we predict *LEV* should be negatively associated with R&D spending, as a firm with higher leverage has stricter financial constraints and less freedom to conduct R&D.

For the second and third hypotheses, we conduct the following regression model using the subsample of firms with a product differentiation strategy or firms with a cost leadership strategy respectively.

$$Performance_{it+3} = \beta_0 + \beta_1 R\&D(\%)_{i,t} + \beta_2 R\&D(\%)^2_{i.t} + \sum_k \gamma_k Control_{it}^k + Year + Ind + \varepsilon_{it}. \tag{2}$$

We use three indicators to measure the firms' future performance. The main indicators are *ROA* and *ROE*, which are fundamental accounting measurements commonly used in the literature. *ROA* is measured as the ratio of net profit to average total assets, while *ROE* is the ratio of net profit to average shareholders' equity. We also use *TOBINQ* as a robustness check, which is the market value divided by total assets. However, we do not make a strong prediction about the relationship between R&D and *TOBINQ* given the inefficiency of the Chinese stock market. Because of noise traders (Morck et al. 2000; Xiong and Yu 2011) and political interruptions (Brunnermeier et al. 2017) in the Chinese stock market, the market value used to calculate *TOBINQ* is vulnerable to irrational trading and macro shocks, which makes *TOBINQ* less efficient as an indicator of investors' belief about the firm's future performance. We then use three years of forward indicators to measure future performance. We include R&D (%) and its square value into the regression to test whether there is a non-linear relationship. Control denotes *SIZE*, *LEV* and *SALES* which is the log of operating revenue. We also include year and industry dummies to control for fixed effects. For the firms using a product differentiation strategy, we predict the coefficient of *R&D* (%) to be significantly positive, but the coefficient of $R\&D^2$ (%) to be insignificant, which means there is a linear relationship between R&D spending and future performance, and the firms can improve their performance with more R&D spending. On the other hand, the firms which adopt a cost leadership strategy should have a positive coefficient of *R&D* (%) and a negative coefficient of $R\&D^2$ (%), indicating an inversed U-shape between R&D spending and future performance.

Empirical results

Data and sample

The fundamental accounting data of Chinese listed firms is obtained from the China Stock Market and Accounting Research (CSMAR) Database. As CSMAR only contains capitalized R&D spending, we obtain total R&D spending from the iFinD Database. Our sample contains all listed firms in the Shanghai and Shenzhen stock exchanges as well as the GEM Board. Since the data on R&D spending is limited before 2009, our sample period covers eight years from 2009 to 2016. We then exclude the firm-years observations when the shares are under special treatment (ST stocks), which means the listed companies have abnormal financial conditions. Finally, we restrict the sample to manufacturing firms according to the Industry Classifying Index Code of Listed Companies released by the China Securities Regulatory Commission (CSRC). Our final sample includes 8386 firm-year observations for 1506 firms.

Table 1 reports the sample distribution across industries and years. In Panel A, the machinery, equipment and instrument industry covers 555 firms, which is about 37% of the total sample. In contract, there are less than 100 firms for the textile, clothes and fur, timber and furniture, paper making and printing, and other manufacturing industries. The number of firms has increased steadily over the sample years as shown in Panel B. There are only 630 sample firms in 2009, but the number quickly doubles to 1395 in 2016.

Table 2 provides the descriptive statistics and correlation matrix for the sample. In Panel A, the descriptive statistics for the full sample and the subsample with positive R&D spending are reported separately. For the full sample, the mean and median values of the percentage of R&D spending to operating income is 3.259 and 3.1 respectively. It also shows considerable variations from 0 for the 5th percentile to 8.488 for the 95th percentile. The mean value of *ROA* is 0.045 while *ROE* and *TOBINQ* have a mean value of 0.07 and 2.289 respectively. The mean values of *OPROF* and *ATURN* are 0.072 and 3.865 respectively. *SIZE* has a mean value of 21.923 and a median value of 21.745. *LEV* and *SALES* have mean values of 0.408 and 21.359 respectively. As for the sample with positive R&D spending, the descriptive statistics of the variables are similar to the full sample. For example, the mean and median values of *ROA* are 0.046 and 0.042 respectively, while the mean values for *SIZE*, *LEV* and *SALES* are 21.912, 0.399 and 21.34 respectively. Panel B shows the correlation matrix of the variables. *R&D (%)* has a positive association with *ROA*, *ROE*, *TOBINQ* and *OPROF*, but a negative relationship with *ATURN*, *SIZE*, *LEV* and *SALES.*

Empirical analysis of R&D and strategic position

In this section, we provide detailed analysis of the R&D spending and the classification of strategic position. Table 3 shows the descriptive statistics of R&D spending across industries and years. Both the number of the firms with positive R&D spending and its corresponding percentage are presented in the table.

Table 1 Sample distribution

Industry	No. of Firms	Percentage
Panel A: Industry Distribution		
Food and beverage	102	6.77%
Textile, clothes and fur	68	4.52%
Timber and furniture	17	1.13%
Paper making and printing	36	2.39%
Petroleum, chemistry, rubber and plastic	230	15.27%
Electronics	139	9.23%
Metal and non-metal	194	12.88%
Machinery, equipment and instrument	555	36.85%
Medicine and biological products	154	10.23%
Other manufacturing	11	0.73%
Total	1506	100%
Panel B: Yearly Distribution		
Year	No. of firm-year obs.	Percentage
2009	630	7.51%
2010	712	8.49%
2011	916	10.92%
2012	1078	12.85%
2013	1172	13.98%
2014	1211	14.44%
2015	1272	15.17%
2016	1395	16.63%
Total	8386	100%

Notes. Panel A shows the distribution of sample firms across industries according to the Industry Classifying Index Code of Listed Companies released by the China Security Regulatory Commission (CSRC). Panel B shows the distribution of firm-year observations across years

In Panel A, about 89.1% of the firms have positive R&D spending. Consistent with common wisdom, the machinery, equipment and instrument, electronics, and medicine and biological products industries have the highest percentage of positive R&D spending firms. The mean and median values are the highest for the electronics industry, at 5.36 and 4.602 respectively, followed by the machinery, equipment and instrument industry with the respective values of 4.189 and 3.69. In Panel B, the number and the percentage of the firms with positive R&D spending have increased over the years. In 2009, about 57.3% of the sample firms had R&D spending, which increased to 97.6% in 2016. The mean and median values of R&D spending also increased from 1.29 and 0.118 to 4.009 and 3.57 respectively. With increasing coverage and levels of R&D spending, it becomes more and more important to understand how it affects corporate performance and the economy.

We then classify firms into four strategic positions: cost leadership strategy, product differentiation strategy, dual strategies and indistinct strategy. The mean and median values of *OPROF*, *ATURN* and *R&D* for different strategies are shown in Panel A of Table 4 for the full sample and in Panel B for the sample with positive R&D spending. The cost leadership strategy has higher levels of *ATURN*, with the mean and median values at 6.334 and 4.922 respectively, and lower levels of *OPROF*, with the mean and

Table 2 Descriptive statistics and correlation matrix

Variables	Mean	Std.Dev.	5th Pctl.	25th Pctl.	Median	75th Pctl.	95th Pctl.	
Panel A: Descriptive Statistics								
R&D (%)	3.259	2.823	0.000	1.050	3.100	4.390	8.488	
ROA	0.045	0.052	−0.033	0.014	0.040	0.073	0.135	
ROE	0.070	0.098	−0.073	0.027	0.068	0.118	0.221	
TOBINQ	2.289	1.741	0.470	1.078	1.804	2.961	5.809	
OPROF	0.072	0.117	−0.091	0.017	0.063	0.131	0.254	
ATURN	3.865	3.520	0.874	1.633	2.762	4.746	10.667	
SIZE	21.923	1.164	20.360	21.094	21.745	22.544	24.194	
LEV	0.408	0.200	0.097	0.247	0.403	0.565	0.736	
SALES	21.359	1.364	19.395	20.431	21.205	22.109	23.963	
If R&D (%) > 0								
R&D (%)	3.595	2.753	0.170	1.741	3.270	4.590	8.760	
ROA	0.046	0.052	−0.030	0.015	0.042	0.074	0.135	
ROE	0.071	0.095	−0.066	0.028	0.069	0.118	0.216	
TOBINQ	2.320	1.749	0.470	1.104	1.835	3.020	5.871	
OPROF	0.075	0.117	−0.085	0.018	0.066	0.135	0.261	
ATURN	3.852	3.430	0.895	1.685	2.797	4.739	10.489	
SIZE	21.912	1.150	20.369	21.098	21.734	22.512	24.162	
LEV	0.399	0.198	0.094	0.239	0.392	0.548	0.729	
SALES	21.340	1.344	19.406	20.422	21.176	22.081	23.872	
Panel B: Correlation Matrix								
	R&D (%)	ROA	ROE	TOBINQ	OPROF	ATURN	SIZE	LEV
ROA	0.085***							
ROE	0.018*	0.886***						
TOBINQ	0.267***	0.344***	0.184***					
OPROF	0.141***	0.808***	0.691***	0.290***				
ATURN	−0.055***	0.272***	0.272***	0.056***	0.099***			
SIZE	−0.212***	−0.047***	0.070***	−0.489***	−0.077***	0.030***		
LEV	−0.350***	−0.405***	− 0.196***	−0.481***	− 0.447***	−0.012	0.515***	
SALES	−0.337***	0.037***	0.153***	−0.472***	−0.088***	0.215***	0.913***	0.529***

Notes. Panel A shows the descriptive statistics while Panel B shows the correlation matrix and reports Pearson correlations below the diagonal with ***, ** and * indicating significance at the 1%, 5% and 10% levels respectively

median values as 0.015 and 0.024 respectively. In contrast, the firms adopting product differentiation have higher levels of *OPROF* and lower levels of *ATURN*. The mean and median values for this group are 0.154 and 0.136 for *OPROF* and 1.756 and 1.754 for *ATURN*. Moreover, the average R&D spending is highest for the firms adopting a product differentiation strategy, with mean and median values at 3.899 and 3.685, and lowest for the firms adopting a cost leadership strategy, with mean and median values at 2.534 and 2.154 respectively. The results are consistent with Hypothesis 1 that there is more R&D spending for the firms that adopt product differentiation than the ones adopting cost leadership. The subsample analysis with positive R&D spending has similar results. The firms which adopt product differentiation have mean and median values of R&D spending at 4.269 and 3.89, while the values are 2.876 and 2.54 for the firms adopting cost leadership.

Table 3 Descriptive statistics of R&D (%)

	No. of obs.	No. of obs. (R&D > 0)	Percentage (R&D > 0)	Mean	Median	Std. Dev.	25th Pctl.	75th Pctl.
Panel A								
Industry								
Food and beverage	587	474	80.7%	1.306	0.520	1.735	0.070	2.190
Textile, clothes and fur	395	334	84.6%	1.837	1.730	1.426	0.611	3.010
Timber and furniture	83	68	81.9%	1.641	1.580	1.269	0.250	2.610
Paper making and printing	225	207	92.0%	2.371	2.019	1.856	0.920	3.540
Petroleum, chemistry, rubber and plastic	1308	1150	87.9%	2.375	2.585	2.029	0.296	3.585
Electronics	739	696	94.2%	5.360	4.602	3.578	3.190	6.756
Metal and non-metal	1156	994	86.0%	2.149	1.740	2.131	0.200	3.451
Machinery, equipment and instrument	2971	2826	95.1%	4.189	3.690	2.886	2.660	5.120
Medicine and biological products	871	811	93.1%	3.517	3.210	2.752	1.499	4.873
Other manufacturing	51	42	82.4%	2.083	2.406	1.480	0.200	3.080
Total	8386	7602	89.1%	2.683	2.408	2.114	0.990	3.821
Panel B								
Year								
2009	630	361	57.3%	1.290	0.118	2.015	0.000	2.190
2010	712	507	71.2%	1.838	1.065	2.241	0.000	3.075
2011	916	803	87.7%	2.728	2.566	2.502	0.612	3.805
2012	1078	1027	95.3%	3.327	3.190	2.584	1.550	4.243
2013	1172	1133	96.7%	3.562	3.279	2.816	1.808	4.469
2014	1211	1169	96.5%	3.654	3.310	2.913	1.740	4.620
2015	1272	1240	97.5%	3.875	3.435	2.909	2.010	5.020
2016	1395	1362	97.6%	4.009	3.570	2.902	2.270	5.140
Total	8386	7602	87.5%	3.035	2.567	2.610	1.249	4.070

Notes. This table shows the percentage of observations with positive R&D spending and the descriptive statistics of R&D spending across industries in Panel A and across years in Panel B. *R&D* (%) is the percentage of R&D spending to operating income

The testing results for the stability of the strategy are shown in Table 5. As firms do not change their strategic position frequently, we predict that the strategy should be persistent over time. We count the number and calculate the percentage of the firms with different strategies in year t and year $t + 1$. Consistent with the prediction, 79.7% of the firms adopting the cost leadership strategy continue to adopt the same strategy in the following years. Only 9.2% of the firms changed to dual strategies and 10.0% of the firms adopted the indistinct strategy. Similarly, the firms adopting the product differentiation strategy are also more likely to adopt the same strategy in the following years, at a percentage of 68.6%. The results confirm the classification of firm strategies.

Table 6 shows the results of R&D spending regressed on dummies of strategic positions and other control variables. Columns (1) and (2) report the results of the full sample, with year and industry fixed effects in column (2). Consistent with the hypothesis, we find the coefficient of *PD_Strategy* is significantly positive with or without the year and industry fixed effects, which means the firms pursing product differentiation have

Table 4 Descriptive statistics of different strategy groups

Panel A							
ATURN	High	Cost Leadership Strategy			Dual Strategies		
			Mean	Median		Mean	Median
		OPROF	0.015	0.024	OPROF	0.148	0.124
		ATURN	6.334	4.922	ATURN	5.797	4.551
		R&D (%)	2.534	2.154	R&D (%)	3.693	3.390
		No. of Obs.	1850		No. of Obs.	2384	
	Low	Indistinct Strategy			Product Differentiation Strategy		
			Mean	Median		Mean	Median
		OPROF	−0.028	0.010	OPROF	0.154	0.136
		ATURN	1.576	1.515	ATURN	1.756	1.754
		R&D (%)	2.880	2.650	R&D (%)	3.899	3.685
		No. of Obs.	2306		No. of Obs.		1846
		Low			High		
				OPROF			
Panel B: if R&D (%) > 0							
ATURN	High	Cost Leadership Strategy			Dual Strategies		
			Mean	Median		Mean	Median
		OPROF	0.016	0.024	OPROF	0.149	0.126
		ATURN	6.149	4.844	ATURN	5.766	4.538
		R&D (%)	2.876	2.540	R&D (%)	3.899	3.500
		No. of Obs.	1630		No. of Obs.	2258	
	Low	Indistinct Strategy			Product Differentiation Strategy		
			Mean	Median		Mean	Median
		OPROF	−0.027	0.010	OPROF	0.154	0.136
		ATURN	1.596	1.539	ATURN	1.780	1.781
		R&D (%)	3.275	3.040	R&D (%)	4.269	3.890
		No. of Obs.	2028		No. of Obs.	1686	
		Low			High		
				OPROF			

Notes. This table shows the mean and median values of *OPROF*, *ATURN* and *R&D* (%) of sample firms using different strategies: the cost leadership strategy, dual strategies, indistinct strategy and product differentiation strategy. Panel A shows the statistics with all sample firms while Panel B only uses the firms with positive R&D spending

higher R&D spending. The coefficient of *PD_Strategy* with year and industry fixed effects is 0.3701 and significant at the 1% level. Meanwhile, the firms which adopt cost leadership, the coefficient of *CL_Strategy* is − 0.3475 without fixed effects and − 0.4505 with fixed effects. Both are significant at the 1% level, indicating that the firms which adopt cost leadership have lower R&D spending. *SIZE* has a negative coefficient of − 0.1171 in column (1) and − 0.2340 in column (2), which means large firms have a lower percentage of R&D spending to operating income. *LEV* also has a negative relationship with R&D, indicating that firms with higher leverage have lower R&D spending. Columns (3) and (4) report the regression results using the subsample of positive R&D spending, which decreases the sample from 8386 observations to 7602 observations. The results remain robust. The coefficients of *PD_Strategy* are 0.2228 and 0.4285

Table 5 Stability of the strategy

		Year *t* + *1*			
		Cost Leadership Strategy	Product Differentiation Strategy	Dual Strategies	Indistinct Strategy
Year *t*	Cost Leadership Strategy	1338	17	155	168
		79.7%	1.0%	9.2%	10.0%
	Product Differentiation Strategy	14	1158	156	361
		0.8%	68.6%	9.2%	21.4%
	Dual Strategies	255	233	1541	70
		12.1%	11.1%	73.4%	3.3%
	Indistinct Strategy	142	221	37	1597
		7.1%	11.1%	1.9%	80.0%

respectively while the coefficients of *CL_Strategy* are – 0.3459 and – 0.3947 respectively. All these coefficients are significant at the 1% level.

Considering potential endogenous issues, we also examine how R&D spending changes when firms change their strategies. We use the change of R&D spending as the dependent variable and select the firms which adopt product differentiation in year *t–1* as the testing sample. We then identify the firms which change their strategy to cost leadership as testing firms where *PD-CL* equals 1, and the remaining firms as the control group where *PD-CL* equals 0. The regression results for the pre-product differentiation strategy firms are presented in column (1) of Table 7. The coefficient of *PD-CL* is significantly negative, which means that R&D spending decreases when firms change their strategy from product differentiation to cost leadership. Similarly, the results of pre-cost leadership adopters are reported in column (2) of Table 7. The

Table 6 Regression analysis of R&D spending for firms with different strategies

			If R&D (%) > 0	
	(1)	(2)	(3)	(4)
	Coef./t	Coef./t	Coef./t	Coef./t
PD_Strategy	0.1347*	0.3701***	0.2228***	0.4285***
	(1.82)	(5.75)	(2.94)	(6.35)
CL_Strategy	−0.3475***	−0.4505***	−0.3459***	−0.3947***
	(−4.70)	(−6.98)	(−4.51)	(−5.77)
SIZE	−0.1171***	− 0.2340***	− 0.1761***	−0.2422***
	(−4.05)	(−9.05)	(−5.77)	(−8.67)
LEV	−4.3432***	−3.1322***	−3.8661***	−3.1823***
	(−24.62)	(−19.86)	(−20.91)	(−18.88)
_cons	7.6466***	8.6405***	9.0213***	8.9103***
	(12.67)	(13.97)	(14.19)	(13.27)
Year	No	Yes	No	Yes
Ind	No	Yes	No	Yes
R-squared	0.127	0.348	0.122	0.312
No. of obs.	8386	8386	7602	7602

Notes. This table shows the regression results of R&D spending on different strategies and other control variables. Year and Industry dummies are included to control for the fixed effects in columns (2) and (4). Columns (3) and (4) use the subsample with positive R&D spending. *T*-statistics are reported in the parentheses. Coefficients marked ***, ** and * are significant at the 1%, 5% and 10% levels, respectively

Table 7 Regression analysis of R&D spending changes when firms change their strategies

Dependent Variable = △*R&D (%)*		
	(1)	(2)
	Strategy = PD (*t*−*1*)	Strategy = CL (*t*−*1*)
PD-CL	−0.8127***	
	(−2.52)	
CL-PD		0.3875*
		(1.91)
SIZE	0.0688*	0.0328
	(1.89)	(1.35)
LEV	−0.1009	0.0605
	(−0.47)	(0.38)
_cons	−1.8349**	−0.7286
	(−2.29)	(−0.84)
Year	Yes	Yes
Ind	Yes	Yes
R-squared	0.011	0.021
No. of obs.	1649	1658

Notes. This table shows the regression results of R&D spending changes when firms change their strategies. The dependent variable is the change of R&D (%). Column (1) reports the results of the previous product differentiation sample while Column (2) reports on the pre-cost leadership strategy adopters. *PD-CL* is a dummy variable that equals 1 if firms change their product differentiation strategy to cost leadership, *CL-PD* is a dummy variable that equals 1 if firms change their cost leadership strategy to product differentiation. *T*-statistics are reported in the parentheses. Coefficients marked ***, ** and * are significant at the 1%, 5% and 10% levels, respectively

coefficient of *CL-PD* is positive, indicating that changing strategy from cost leadership to product differentiation increases R&D spending.

R&D spending and future performance

In this section, we report the results exploring the relationship between R&D spending and future performance. The regression results of firms' future performance to R&D spending are shown in Table 8. We first conduct the regression analysis for the sample firms adopting a product differentiation strategy, and then analyze the situation of the firms with a cost leadership strategy. For the firms with a product differentiation strategy, future performance is found to be positively associated with R&D spending. The coefficient of *R&D (%)* is 0.0012 for future *ROA*, 0.0019 for future *ROE* and 0.0446 for future *TOBINQ*. Both the coefficients for *ROA* and *ROE* are significant at the 5% level while remaining significant at the 1% level for *TOBINQ*. We also include the square of *R&D (%)* into the regression to test whether the relationship is U-shaped. We find the coefficients of $R\&D^2(\%)$ for future performance are all insignificant with small values, indicating their associations are not U-shaped. For the control variables, *SIZE* has a significantly negative coefficient for *ROA*, *ROE* and *TOBINQ*, indicating that small firms could have better performance in the future. *LEV* is negatively associated with future performance, which means the firms with higher leverage could perform worse in the future. *SALES* is positively associated with *ROA*, *ROE*, but insignificant for *TOBINQ*. Overall, the results indicate that the higher the R&D spending, the better the future performance.

Table 8 Regression analysis of firm performance to R&D spending with different strategies

	Product Differentiation Strategy					
	ROA		ROE		TOBINQ	
R&D (%)	0.0012**	0.0030**	0.0019**	0.0051**	0.0446***	0.0515
	(2.08)	(2.42)	(1.96)	(2.37)	(2.57)	(1.38)
$R\&D^2$ (%)		−0.0002		− 0.0003		− 0.0006
		(−1.64)		(− 1.66)		(−0.21)
SIZE	−0.0368***	−0.0362***	− 0.0562***	−0.0551***	− 0.6114***	−0.6091***
	(−9.18)	(−9.00)	(−8.25)	(−8.07)	(−5.11)	(−5.07)
LEV	−0.072***	−0.0709***	− 0.0344**	−0.0327*	−1.4219***	−1.4193***
	(−6.99)	(−6.89)	(−1.97)	(−1.87)	(−4.67)	(− 4.66)
SALES	0.0408***	0.0404***	0.0643***	0.0637***	−0.0567	−0.0581
	(11.51)	(11.39)	(10.67)	(10.55)	(−0.54)	(−0.55)
_cons	0.015	0.005	−0.0466	−0.0637	17.527***	17.4906***
	(0.39)	(0.13)	(−0.72)	(−0.97)	(15.33)	(15.12)
Year	Yes	Yes	Yes	Yes	Yes	Yes
Ind	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.223	0.225	0.182	0.183	0.532	0.531
No. of obs.	940	940	940	940	907	907
	Cost Leadership Strategy					
	ROA		ROE		TOBINQ	
R&D (%)	0.001	0.0038***	0.0031*	0.0094***	0.0124	− 0.0374
	(1.62)	(3.19)	(1.93)	(2.98)	(0.67)	(−1.04)
$R\&D^{2}$(%)		−0.0003***		−0.0006**		0.0048
		(−2.75)		(−2.31)		(1.6)
SIZE	−0.0142***	− 0.014***	− 0.0283***	− 0.0279***	− 0.6413***	− 0.6436***
	(−4.75)	(−4.7)	(− 3.57)	(− 3.52)	(−7.04)	(−7.07)
LEV	− 0.059***	− 0.0595***	− 0.077***	− 0.0781***	−2.1772***	− 2.1700***
	(−7)	(−7.08)	(− 3.44)	(− 3.5)	(−8.44)	(−8.42)
SALES	0.019***	0.0189***	0.0406***	0.0404***	0.0906	0.0908
	(7.09)	(7.07)	(5.71)	(5.69)	(1.11)	(1.12)
_cons	−0.021	− 0.0258	− 0.1333**	− 0.144**	16.0283***	16.1259***
	(−0.83)	(−1.02)	(−2.00)	(−2.16)	(20.37)	(20.45)
Year	Yes	Yes	Yes	Yes	Yes	Yes
Ind	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.211	0.217	0.132	0.136	0.508	0.508
No. of obs.	970	970	970	970	911	911

Notes. This table shows the regression results of three-year forward firm performance on R&D spending and its square value for the firms with a product differentiation strategy and a cost leadership strategy. *T*-statistics are reported in the parentheses. Coefficients marked ***, ** and * are significant at the 1%, 5% and 10% levels, respectively

The regression results for firms with a cost leadership strategy are reported at the bottom of Table 8. Contrary to the results of the product differentiation strategy, the coefficient of $R\&D^2(\%)$ is significantly negative when the dependent variables are future *ROA* and *ROE*. The coefficients of *R&D (%)* and $R\&D^2(\%)$ for *ROA* are 0.0038 and − 0.0003 respectively, and both are significant at the 1% level. That means the relationship of R&D spending and future ROA has an inversed U-shape. When the level of R&D spending is low, increasing R&D spending helps to improve firms' future *ROA*. However, when the level of R&D spending is high, the future *ROA* decreases with more R&D spending. Similarly, the coefficients of *R&D (%)* and *R&D*^{2}*(%)* for *ROE* are 0.0094 and – 0.0006 respectively, with at least 5% significance, which means the relationship of R&D spending and future *ROE* is also an inversed U-shape. For *TOBINQ*, the coefficients of *R&D (%)* and *R&D*^{2}*(%)* are not significant. This may be caused by the inefficiency of the Chinese stock market making *TOBINQ* less efficient as an indicator of investors' confidence about a firm's future performance. Overall, two of the performance measurements show consistent results with our hypotheses. Similar to the results of the product differentiation strategy, *SIZE* and *LEV* are negatively associated with future performance while *SALES* is positively associated with future performance, indicating that small firms with lower leverage and higher sales may have better performance in the future.

We then check the break point of the inversed U-shape to see whether the firms with a cost leadership strategy have proper R&D spending. As shown in Table 8, the break point of *R&D (%)* is 6.33 for *ROA* and 7.83 for *ROE*, which means firms' three years forward performance is the highest when *R&D (%)* is around 6 to 8, when other factors are properly controlled. However, the 95th percentile of *R&D (%)* for the cost leadership subsample is 6.76, indicating that in practice most firms have less R&D spending than is appropriate according to these results. Instead of experiencing excess R&D spending, these firms are conservative and are actually experiencing a diminishing marginal benefit of R&D spending. In practice, when firms increase their R&D spending from a lower level, the benefit of innovation decreases while the costs increases, and they stop further R&D spending before the costs exceed the benefits.

Finally, we test whether the relationship of R&D spending and future performance is different for state-owned firms in China. The regression results are reported in Table 9. Panel A of Table 9 shows the results for SOEs. For the firms with a product differentiation strategy, the association between R&D spending and future performance is insignificant. The coefficients of *R&D (%)* are 0, – 0.0009 and 0.053 respectively when the dependent variables are future *ROA*, *ROE* and *TOBINQ*. For the control variables, *SIZE* and *LEV* are negatively associated with future performance, while *SALES* is positively associated with *ROA* and *ROE*. The sample size is relatively small. Only 96 observations are used in the regression, indicating the success of share structure reform in China. The relationship of R&D spending and future performance also vanishes for the firms with a cost leadership strategy. The coefficients of *R&D*^{2}*(%)* are – 0.0001, – 0.0003 and – 0.0094 with no significance when the dependent variables are *ROA*, *ROE* and *TOBINQ* respectively. *LEV* is negatively associated with future performance while *SALES* is positively associated with *ROA* and *ROE*. *SIZE* is insignificant for SOEs, indicating that firm size does not matter for future performance for state-owned firms.

The main results hold for non-SOE firms as shown in Panel B of Table 9. Future performance shows a significantly positive association with R&D spending for firms that adopt a product differentiation strategy, with the coefficient values as 0.0014, 0.0025 and 0.048 for *ROA*, *ROE* and *TOBINQ* respectively. For firms with a cost leadership strategy, there is an inversed U-shape between R&D spending and future performance measured as *ROA* and *ROE*. *SIZE* is negatively associated with future performance for both types of firms. *LEV* is negatively associated with *ROA* and *TOBINQ* while *SALES*

Table 9 Regression analysis of firm performance to R&D spending with different strategies—State-owned Firms

	Product Differentiation Strategy					
	ROA		ROE		TOBINQ	
Panel A: SOE Firms						
R&D (%)	0.0000	−0.0005	− 0.0009	− 0.0017	0.0530	0.1721*
	(0.04)	(−0.15)	(− 0.43)	(− 0.32)	(1.22)	(1.72)
R&D ^{2}(%)		0.0000		0.0001		−0.0094
		(0.18)		(0.16)		(−1.32)
SIZE	−0.0279***	−0.0279***	− 0.0469***	−0.0468***	− 0.0838	−0.0777
	(−3.35)	(−3.33)	(−3.2)	(−3.18)	(−0.31)	(−0.29)
LEV	−0.0943***	−0.0947***	− 0.0946*	−0.0952*	− 3.5923***	−3.5632***
	(−3.44)	(−3.42)	(−1.96)	(−1.95)	(− 3.97)	(− 3.96)
SALES	0.0294***	0.0292***	0.0507***	0.0505***	−0.0714	−0.0463
	(3.73)	(3.67)	(3.67)	(3.6)	(−0.28)	(−0.18)
_cons	0.0460	0.0500	0.0223	0.0284	6.9146**	5.9989**
	(0.53)	(0.55)	(0.15)	(0.18)	(2.47)	(2.09)
Year	Yes	Yes	Yes	Yes	Yes	Yes
Ind	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.370	0.362	0.260	0.251	0.573	0.577
No. of obs.	96	96	96	96	92	92
	Cost Leadership Strategy					
	ROA		ROE		TOBINQ	
R&D (%)	0.0006	0.0016	0.0027	0.0058	0.0308	0.1721*
	(0.4)	(0.55)	(0.6)	(0.69)	(0.9)	(1.72)
R&D ^{2}(%)		−0.0001		−0.0003		− 0.0094
		(−0.41)		(− 0.44)		(−1.32)
SIZE	−0.0124*	− 0.0122*	− 0.0264	−0.0256	− 0.2375	− 0.0777
	(− 1.76)	(− 1.71)	(− 1.26)	(− 1.21)	(− 1.43)	(− 0.29)
LEV	− 0.1178***	− 0.1179***	− 0.2777***	−0.2783***	−2.9421***	−3.5632***
	(−5.33)	(−5.32)	(− 4.22)	(−4.22)	(− 5.63)	(−3.96)
SALES	0.0225***	0.0222***	0.055***	0.0541***	−0.0307	−0.0463
	(3.56)	(3.49)	(2.92)	(2.86)	(−0.21)	(−0.18)
_cons	−0.1391**	−0.1398**	− 0.4686***	−0.4707***	8.8136***	5.9989**
	(−2.59)	(− 2.59)	(− 2.93)	(− 2.93)	(7.02)	(2.09)
Year	Yes	Yes	Yes	Yes	Yes	Yes
Ind	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.281	0.278	0.277	0.273	0.543	0.540
No. of obs.	189	189	189	189	182	182
Panel B: Non-SOE Firms						
	Product Differentiation Strategy					
	ROA		ROE		TOBINQ	
R&D (%)	0.0014**	0.0034**	0.0025**	0.0058**	0.048**	0.0534
	(2.17)	(2.45)	(2.28)	(2.47)	(2.54)	(1.32)
R&D ^{2}(%)		−0.0002		− 0.0003		−0.0005
		(−1.62)		(−1.58)		(−0.15)

Table 9 Regression analysis of firm performance to R&D spending with different strategies—State-owned Firms *(Continued)*

	Product Differentiation Strategy					
	ROA		ROE		TOBINQ	
SIZE	− 0.0373***	− 0.0366***	− 0.055***	− 0.0539***	− 0.7429***	−0.7411***
	(−8.3)	(−8.12)	(−7.22)	(−7.05)	(−5.58)	(−5.54)
LEV	−0.0691***	− 0.0684***	− 0.0285	− 0.0273	− 1.3342***	− 1.3327***
	(− 6.22)	(− 6.15)	(− 1.51)	(− 1.45)	(−4.11)	(−4.1)
SALES	0.0419***	0.0415***	0.0651***	0.0643***	− 0.0078	− 0.009
	(10.73)	(10.59)	(9.83)	(9.7)	(−0.07)	(− 0.08)
_cons	0.0005	−0.0093	−0.0912	− 0.1074	19.2701***	19.244***
	(0.01)	(−0.22)	(−1.27)	(−1.48)	(15.36)	(15.18)
Year	Yes	Yes	Yes	Yes	Yes	Yes
Ind	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.207	0.209	0.176	0.177	0.525	0.524
No. of obs.	844	844	844	844	799	799
	Cost Leadership Strategy					
	ROA		ROE		TOBINQ	
R&D (%)	0.001	0.0041***	0.003*	0.0094***	0.0021	−0.0668
	(1.55)	(3.16)	(1.73)	(2.8)	(0.1)	(−1.62)
R&D ^{2}(%)		−0.0003***		−0.0006**		0.0067*
		(−2.75)		(−2.23)		(1.94)
SIZE	−0.0145***	−0.0144***	− 0.029***	−0.0288***	− 0.7896***	−0.7897***
	(−4.33)	(−4.32)	(−3.38)	(−3.36)	(−7.51)	(−7.53)
LEV	−0.0507***	−0.0513***	− 0.0489**	−0.0502**	−1.8836***	−1.874***
	(−5.47)	(−5.56)	(−2.06)	(−2.12)	(−6.44)	(−6.42)
SALES	0.0190***	0.0191***	0.0404***	0.0404***	0.1089	0.1046
	(6.35)	(6.39)	(5.26)	(5.29)	(1.16)	(1.12)
_cons	−0.0117	−0.0179	−0.1107	−0.1234	19.1189***	19.2851***
	(−0.39)	(−0.59)	(−1.43)	(−1.59)	(19.35)	(19.48)
Year	Yes	Yes	Yes	Yes	Yes	Yes
Ind	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.202	0.210	0.099	0.104	0.513	0.515
No. of obs.	781	781	781	781	729	729

Notes. This table shows the subsample regression results of three-year forward firm performance on R&D spending and its square value. Panel A shows the results of state-owned firms while Panel B shows non-SOE firms. *T*-statistics are reported in the parentheses. Coefficients marked ***, ** and * are significant at the 1%, 5% and 10% levels, respectively

is positively related with *ROA* and *ROE*. Overall, the results for non-SOE firms are consistent with our predictions.

Conclusions

This paper uses Porter's (1980) generic strategies to reexamine how the effect of R&D spending on future performance changes with different strategic positions. Using 1506 listed manufacturing firms in China, we find that R&D spending is higher for firms that adopt a product differentiation strategy than the ones adopting a cost leadership strategy. Furthermore, we show that the R&D spending is positively associated with future performance for the firms with a product differentiation strategy, but turns into an inversed U-shape for the firms with a cost leadership strategy. We also present that R&D spending only affects the future performance of non-SOE firms. As R&D becomes more and more important for Chinese firms, our paper provides valuable guidance and suggestions on the efficient allocation of R&D resources.

Abbreviations

CSMAR: China Stock Market and Accounting Research (CSMAR) database; CSRC: China Securities Regulatory Commission; GEM: Growth Enterprise Market Board; OLS: Ordinary least squares; R&D: Research and development; ST: Special treatment

Availability of data and materials

CSMAR & iFinD Database.

Authors' contributions

Guo helped conceive the study and participated in its design. Wang helped conceive the study, designed and performed the statistical analysis and drafted the manuscript. Wei participated in the design of the study and helped to draft the manuscript. All authors read and approved the final manuscript.

Competing interests

The authors declare that they have no competing interests.

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