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THE EFFECT OF BUSINESS STRATEGY ON R&D EXPENDITURE AND FIRM PERFORMANCE – EVIDENCE FROM TAIWAN

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Abstract:
This paper aims to investigate the effect of generic strategy on R&D spending and the impact of R&D spending on firms' performance conditional on their strategic position. This empirical study uses accounting data of 597 listed Taiwanese firms in the manufacturing industry from 2013 to 2017. The data was obtained from Taiwan Economic Journal (TEJ) database. The results indicate that firms that adopt a differentiation strategy have more R&D spending than companies with a cost leadership strategy. Furthermore, the authors find that R&D spending positively affects firms' performance if they pursue a differentiation strategy. Meanwhile, the relationship between R&D spending and firm performance forms an inverted U-shape for those who adopt a cost leadership strategy. First, for firms adopting the differentiation strategy, the investment in R&D is critical because the more investment on R&D these firms spend, the better performance they will gain. Second, for firms with a cost-leadership strategy, R&D spending is also essential to improve efficiency. However, they should allocate the budgets wisely and reasonably, as controlling cost is the main focus of this strategy to keep their competitive advantages. This study examines the relationship between R&D spending, business strategy, and firm performance in Taiwan. Further, the study suggests that manufacturing firms in Taiwan allocate their resources wisely and efficiently according to their system.

Key words: *business strategy, firm performance, R&D spending*

INTRODUCTION

Technology development is a critical factor that drives industry upgrades and economic growth. The intensity of research and development (R&D) spending, as one of the most important ways to generate new technology, is found to be positively associated with firm performance and market value [1, 2, 3, 4]. However, other researchers also find that R&D is associated with risk. For example, R&D expenditure positively relates to return volatility [5], and Shi [6] argues that risk from R&D activities dominates their benefits. When it comes to different firms' characteristics, the argument of optimal level of R&D spending becomes even more complicated [4].

Instead of focusing on external objective conditions, in this paper, we would like to examine the relationship between R&D spending and firm performance conditional on corporate strategic positions, also known as the internal generic strategy. For that purpose, this research emphasizes a manager's initiative's role in R&D spending on firm performance. Strategic positions followed Porter [7]'s generic strategies: differentiation, cost leadership, and focus. By applying these strategies, firms can achieve a competitive advantage over their competitors [8]. Among the three generic strategies, differentiation and cost leadership are likely to dominate business literature while the focus generally receives less attention. Differentiation is a firm that positions itself with unique products or services and charges a price premium to cover the low volume and high cost. Contrarily, cost leadership (or low-cost strategy) is when a firm pushes down prices to the lowest price level in the industry. Although cost leaders have small profit margins, large volumes compensate them for gaining high profitability.

While many research papers concentrate on finding the relationship between R&D spending and firm performance from the external perspective, few papers discuss the R&D expenditure and performance of firms conditional on internal factors like generic strategies. The purpose of this paper is to fill in this research gap and examine the effect of R&D spending on firm performance under

different strategic positions with the evidence from manufacturing firms in Taiwan.

Data is collected from Taiwan Economic Journal (TEJ) database. The sample contains 597 Taiwanese listed firms in the manufacturing industry and the data period covers five years from 2013 to 2017 in Taiwan, with a total of 2,945 firm-year observations. The results show that firms that adopt a product differentiation strategy tend to spend more on R&D than those with a low-cost strategy. Further results indicate that R&D expenditure has a positive effect on the performance of firms adopting differentiation strategy. For firms with a cost leadership strategy, the relationship between R&D spending and firm performance forms an inverted U-shape.

With those results, we hope the research can make three contributions. First, this research examines the effect of R&D expenditure on firm performance from the internal point of view, a firm's particular strategy to be exact. We want to emphasize that the extent of R&D spending should be consistent with the plans and strategies of the firm and that excessive R&D spending may not always have a positive impact on the firm performance. Second, the research applies Porter [7]'s competitive strategic positions to R&D spending to add to the literature on firms' generic strategies. It also provides a better understanding of firms' generic strategies to help managers find a better way to balance budgets, investment, and firm performance. Finally, this paper offers practical suggestions for Taiwanese manufacturing firms on allocating their R&D resources efficiently according to their strategic positions.

The rest of the paper is structured as follows: Part 2 reviews the literature regarding the impact of generic strategy on R&D spending and the effect of R&D spending on firm performance conditional on strategic position with research hypotheses. Part 3 specifies research methodology, variables measurement, and data description. Part 4 and part 5 presents the empirical results, discussion, and conclusion.

LITERATURE REVIEW

Defining business strategy

The strategy has numerous ways to be defined, but according to Mintzberg [8], a strategy should fulfill the below three typical contingencies: a strategy should be explicit, formed consciously, and developed in advance – before the decision-making step. According to Porter [9], the formation of strategy depends on two matters. The first one is about the attractiveness of industries in terms of long-term profitability generation and the structures and specific characteristics within an industry [9]. It is essential to select and decide which industries to compete in. However, Porter [9] also emphasizes that some companies may still not earn attractive profits within a desirable industry because of a poor-strategy-positioning. Therefore, the second matter is "the determinant of relative competitive position within an industry" [9]. The two factors mentioned above – industry attractiveness and company's positioning – can be shaped by a firm, making them both challenging and exciting. White [10] describes these factors as a business strategy that can address how an industry competes.

The business-level strategy addresses the question of how a firm competes within a specific industry. This seems to be a simple question, but creating a competitive advantage is critical that decides a company's success. Although there are many possible answers to this question, one solution is to think about business-level strategy in terms of generic strategies. The most popular set of generic strategies is built on Porter's theory [7]. A generic strategy is a general way to identify and build a competitive advantage within an industry. Furthermore, according to Barney [11], sustainable competitive advantage includes the exact requirement, but other companies cannot replicate the strategy.

There are three strategies in Porter's generic competitive strategies that firms can possess to differentiate themselves from their competitors and even outperform them. They are Cost leadership, Differentiation, and Focus.

According to Porter [7, 9], the two main types of competitive advantages a company can possess may have various strengths and weaknesses vis-à-vis its competitors: cost leadership and differentiation. Focus, a strategy that typically has less notice and attention, has two variants, cost focus and differentiation focus. The primary difference between focus and the other two generic strategies is that focus strategy aims at a narrow segment in the market while the other two seek competitive advantage in a broad range of industry segments. Due to serving the niche market segment, revenue streams for focusers are usually lower than their competitors because sales of limited targets are typically lower. The opportunity for a focuser to succeed depends on how its rivals perform. If they underperform in meeting the needs of a particular segment, or even over-perform, the opportunity for focuser is open. Otherwise, the focus strategy will not succeed [7, 9]. Focus alone is not taken into this research because it is challenging to identify focusers based on financial statement data alone. Additionally, the focus becomes evident only by studying customer segments. In this study, possible focusers in the samples are identified as cost-leaders or differentiators according to their asset turnover and profit margin levels.

Differentiation creates value to customers with unique features and characteristics of an organization's products and services. The companies that possess differentiation can charge a price premium as they provide buyer value through high quality, good customer service, rapid product innovation, advanced technology. This generic strategy is typically expensive or costlier than non-differentiators. Therefore, to cover the costs, the price premium must be collected [10]. It does not mean that differentiation ignores the importance of cost-efficiency. According to Hambrick [12], the strategy of differentiation merely places costs as a non-key component. Porter [7] argued that differentiation might perform well against all five forces. It requires high initial investments, which work as

entry barriers, and investments must be invested in uncertain intangible assets. Thus differentiation shields the company against the threat of entry. According to Soliman [13], the attractiveness of a high-profit margin may cause an increase in competition, thus eventually push profits down to normal levels; hence the role of high entry barrier of differentiation is undermined. Rivalry among existing competitors can be controlled due to the brand-loyalty, and customers will be less sensitive to price increases. The power of buyers and threat of substitution is small because it is hard to find substitutes for unique products and services. Lastly, the bargaining power of suppliers also can be managed because differentiators charge a premium price. Hence, they can afford to absorb higher costs.

In contrast to differentiation, firms that choose a cost leadership strategy set out to become the low-cost producer in their industry. The breadth of business is often critical to the cost advantage [8]. Cost leaders have a broad scope and operate in numerous segments in the industry, sometimes even serve related industries. Porter [8] suggests that the sources of cost advantage may consist of "– the pursuit of economies of scale, proprietary technology, preferential access to raw materials." Cost leadership focuses on controlling costs to gain a small margin as profits are generated by pushing costs as low as possible [10]. Miller [14] claims that although the market somewhat decides the price of products or services, players who possess cost-leadership try to push their prices lower than the competitors to the level that they may lose the competition. Low price results in low profitability – that would make the low-cost position unfavorable. However, Porter [8] argues that cost leaders still may generate high returns because of cost-efficient processes. In other words, they can expand the sales volume to compensate for a small profit margin. Unlike differentiation, cost leadership is responsive to variables within the business's internal operations rather than outside [10]. According to White's study, the main factor in improving efficiency is enhancing productivity, efficient facilities, maintaining a low cost of sales, R&D, or low overhead costs.

Furthermore, customers that cost leaders target are not seeking premium value, but products have similar features with affordable prices. Customers in this segment are described as price-sensitive and easily be driven by price, leading them to choose cheaper products/services [12]. However, cost leadership is also vulnerable to risk. Porter [8] claims that radical technology innovation may change the available cost position in the industry, hence threatening the cost leaders.

The meaning and characteristics of firm performance are ambiguous, i.e., increasing profitability, obtaining market share can be understood as improving performance. Brealey, et al. [15] listed popular measures of performance which consist of return on assets, market value-added, market-to-book ratio, and economic value-added. In this research, *ROA*, an accounting-based measure, is selected. *ROA* and its modifications have been commonly used among managers for firm performance evaluation [15, 16, 17] and additionally used to measure performance in some strategy-related studies [18, 19, 20]. One of the advantages of *ROA* is that it reflects the firm's profitability and efficiency. Profitability is generally interpreted to measure earnings, while efficiency ratios measure how efficient assets are utilized [15]. *ROA* indicates how profitable a company is relative to its total assets.

It is an advantage of *ROA* to combine efficiency and profitability measures [21]. A firm may achieve very high profitability without being efficient [22]. To measure the efficiency of the firm's investment, an analysis needs to be taken to check whether the returns from investments exceed their funding cost [23], i.e., returns need to be reflected at the cost of generating them. It is possible to increase profitability by simply pumping new capital into the company even though it would not be efficient or in the owners' interest. According to Isberg [22], when observing trends within a single organization over time, *ROA* can give helpful information; but that trend is only truly rational when benchmarked against competitors or best practices within the industry.

There are two ways for a company to increase profitability, either by increasing profit margin or asset turnover, or both [16]. Profit margin reflects the number of dollars in profit that each dollar of sales has generated for a firm [24]. High-profit margin roots are usually from pricing power created by the advantages like product innovation, branding, positioning, first-mover, and market niches. Big-sized companies can improve profit margin by reducing operating expenses to reach better deals with their suppliers, lowering their cost of goods, leading to higher profits [16]. Also, companies with a strong brand identity upon offering products that are hard to imitate can charge a price premium [13].

Asset turnover describes how many dollars in sales each dollar invested in assets has generated for a firm [24]. If a company has a high asset turnover rate, it can generate more profits for fewer assets. It is also a sign of talented and effective management [25]. For example, a way to increase asset utilization is to expand operation time [16]. At the same time, assets remain unchanged, sales increase, and make profitability is higher. If the expected *ROA* is fixed by competition, firms are a trade-off between the asset turnover and the profit margin [15]. On having a positive profit margin, the ability to increase *ROA* is unpredictable with asset turnover. On the other hand, with the negative profit margin, the rise of asset turnover only causes further losses.

The figure below depicts research results by Selling and Stickney [18]. It shows the relationship between *ROA*, profit margin, and asset turnover at 5%, 7%, and 9% at three constant *ROA* levels. All levels of *ROA* can be achieved with different combinations of profit margin and asset turnover. The higher the *ROA* ratio, the longer distance from the axis that the company would locate. (Figure 1 redrawn from Selling and Stickney [18]).

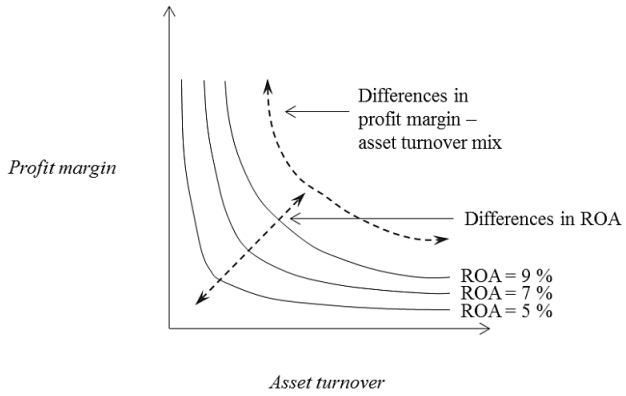

Fig. 1 The ROA curve
Source: Selling and Stickney [18].

Figure 1 above by Selling and Stickney [18] showed clearly how profit margin and asset turnover relate to *ROA* level. The same *ROA* level can yield a considerable profit margin and asset turnover combinations [15]. Though companies with identical *ROA* s have the same profitability, the strategy of these companies may differ considerably [25]. The strategy of differentiation refers to having a high-profit margin while maintaining a modest asset turnover. On the other hand, the cost leadership strategy relies on high volumes and high asset turnover while operating on a small profit margin. Therefore, when looking at figure 1, companies that apply differentiation are supposed to locate in the northwest tail of the ROA curve while the cost leaders are expected to be in the southeast tail. For instance, Brealey, et al. [15] compared fast-food chains and hotels. They have the same *ROA* ratio, but their profit margins and asset turnovers are different. They found that fast-food chains with high asset turnover tend to operate on a low-profit margin. Hotels, however, have relatively low turnover ratios but tend to compensate for this with higher margins. A similar example was given by Fairfield and Yohn [24], as they compared a discount store and a high-end luxury store. Hambrick [12]'s research further shows that high asset turnovers are linked to cost leadership, whereas high-profit margins relate to differentiation.

In Figure 1, Selling and Stickney [18] emphasize that companies' direction is highly informative. Especially the northwest-southeast line (profit margin and asset turnover), movements along this line indicate a change in the firm's internal factors and, more importantly, a change in its strategy and thus the positioning in the industry. In this paper, the use of the DuPont Method is to identify the company's internal competitive strategy and its effect on R&D spending and performance. Although many financial measures can be used to evaluate a company's strategic position, *ROA* decomposition, in particular, provides valuable information on strategy [13, 18, 24, 25] and is therefore selected for this paper.

The effect of business strategy on R&D spending and firm performance

Technological innovation is critical to economic growth, and R&D plays a vital role in the innovation process, which is used to make new products, processes, and services. Little study has been taken to examine the impact of business strategy on R&D expenditure at the firm level. Therefore, instead of analyzing at the industry level, this research is designed to further analyze R&D impact conditional on the core of corporate finance – a company's business strategy. Firms in the same industry may adopt varied strategies that fit their different business vision and mission. Moreover, the research also considers the role of managers' initiative through their business strategy to the effect of R&D spending, rather than focusing on external objective conditions. Li and Chen [17] find that changes in strategies benefit subsequent firm performance. Gunther McGrath and Nerkar [26] find that the likelihood of new R&D investment is influenced by the scope of opportunity, prior experience, and competitive effects. Guo, et al. [27] find that firms that pursue differentiation strategy have more R&D spending than those with a cost leadership strategy for manufacturing firms in China. A similar result was found by Chung and Choi [28] for firms in Korea. They state that R&D expenditure is more important and has more significant impacts on firms' performance for differentiation strategy than the cost leadership. The level of R&D spending should match up with the company's strategy. For example, the R&D expenditure level in high-tech companies is more likely to have a positive relationship with a differentiation strategy [29, 30] rather than cost leadership. Porter [7] also claims that a cost-leader should avoid "marginal customer accounts," which means that too much R&D investment on products is a waste for companies pursuing this strategy. We should expect that firms adopting differentiation strategy invest more in R&D than firms with cost leadership strategies.

H1: There is more R&D spending by firms adopting differentiation strategy than those with cost leadership strategy

The relationship between R&D spending and firm performance has been comprehensive studies in the literature. Previous researches show that the intensity of R&D spending is positively associated with firm performance and market valuation [1, 2, 3, 4]. Further evidence was given by Morbey [31] to show that R&D spending has a significant impact on sales revenue. Sougiannis [3] found that a 1 unit increase in R&D investment results in a 2 unit increase in profits. Concerning R&D expenditure and productivity, Griliches [32] found a positive correlation between them. Tsai and Wang [33] argued that R&D spending in large manufacturing companies significantly impacts business productivity in Taiwan, especially when high-tech companies are more significant than traditional

ones. Furthermore, evidence by Eberhart, et al. [4] also shows that high-tech firms have better abnormal operating performance than low-tech after increasing R&D spending. In addition, Garner, et al. [30] argue that the increase of R&D spending only positively correlates with specific industries, such as the internet and biotech firms. On the other hand, the debate of the optimal level of R&D spending is still ongoing. The impact of R&D expenditure varies with companies' characteristics [4, 29]. It also exists the risk of investment failure in some circumstances [6] because the costs of R&D may outweigh the benefits it could bring. Many efforts have been made to test out the balance between benefits and costs of R&D activities based on mixed evidence from the previous study. One of the well-known practices is to examine how the impact of R&D activity varies across the industry. For example, even though the share-price responses to the increase of R&D investment announcement are averagely significant positive, the research by Chan, et al. [29] shows that there are different results for high – and low-tech firms. Their result states that the market reaction to the high-tech companies is positive abnormal, whereas the low-tech experience negative abnormal returns. The level of R&D spending should match up with a company's strategy to maximize profits. For firms that adopt a differentiation strategy, as unique products aim different from low-cost competitors and the threat of imitations, high R&D spending is critical. This argument is consistent with the literature documented. We posit that R&D spending can improve the performance of firms that are differentiators.

H2: If firms adopt differentiation, R&D spending would have a positive effect on performance

The positive relationship between R&D spending and differentiation makes companies with this strategy more confident in investing in R&D. Contrarily, Guo, et al. [27] find that for Cost leadership adopters, this relationship forms an inverted U-shaped and makes these firms more conservative about R&D spending. Cost leadership emphasizes efficiency, whereas proper R&D expenditure is needed to improve efficiency. It can help design products that can be manufactured more efficiently, reduce product material costs, and optimize production procedures. However, the overutilization of R&D costs is against the principle of cost leadership strategy. Firstly, it conflicts with the strategy of reducing the cost to provide low-price products. Secondly, it is impossible to manufacture on a large scale all new products resulted from R&D activities. Porter [7] claims that a cost leadership strategy should avoid "marginal customer accounts," which means it is a waste of resources for cost-leaders to spend too much R&D cost on particular products. For firms that adopt a cost leadership strategy, efficient R&D spending can lead to the best performance. Therefore, we argue that the level of R&D spending for cost leaders should be used reasonably.

H3: If firms adopt cost leadership, R&D spending would have an inverted U-shaped relationship with the firm's performance

This line of literature also raises a possibility that there may be no actual "one-size-fits-all" principles for optimal R&D expenditure. Taking the inter-and outer-environment perspective to examine the effect of R&D spending on firm performance may be one reason for this debate. This research would like to determine the effect of R&D spending on firm performance in the internal business strategy for manufacturing firms in the Taiwan economy.

METHODOLOGY

Data

The data of fundamental accounting is obtained from Taiwan Economic Journal (TEJ) database. The sample contains 597 Taiwanese listed firms in the manufacturing industry and the data period covers five years from 2013 to 2017, with a total of 2,945 firm-year observations. The data is only gathered among one industry because of the prerequisite of homogeneity of ROA. ROA comparisons are only possible between homogenous companies. It would be more reliable and decrease the need to add more control variables to exclude industry-driven biases in the results.

Table 1 provides the sample distribution across sub-categories within the manufacturing industry and years. There are 19 sub-industries in total. The two of them with the most observation are Electronic Parts/Components (560 observations – 19.02 % of the total sample) and Semiconductor (360 observations – 12.22 % of the total sample). Moreover, Paper, Pulp is the sub-industry with the least observation (10-0.34% of the total sample).

Table 1

Industry categorisation of the sample

ID	Industry	No. of obs	No. of company	Percentage (%)
1	Cement	25	5	0.85
2	Food	110	22	3.74
3	Plastic	110	22	3.74
4	Textiles	120	24	4.07
5	Electric Machinery	290	58	9.85
6	Electrical & Cable	15	3	0.51
7	Glass & Ceramics	15	3	0.51
8	Paper, Pulp	10	2	0.34
9	Iron & Steel	95	19	3.23
10	Rubber	45	9	1.53
11	Automobile	25	6	0.85
12	Chemical	135	34	4.58
13	Oil, Gas & Electricity	50	10	1.70
14	Semiconductor	360	72	12.22
15	Computer	330	66	11.21
16	Optoelectronic	170	34	5.77
17	Communications and Internet	220	44	7.47
18	Electronic Parts/Components	560	112	19.02
19	Other Electronic	260	52	8.83
	Total	**2,945**	**597**	**100**

Note: This table shows the distribution of sample firms across industries according to the Industry Classifying Stock Code of Listed Companies released by Taiwan Stock Exchange Corporation (TWSE).

Measurements of variables

Table 2 below shows all the variables and their measurements in the research.

Table 2

Measurement of variables

Variables	Definition	Measurement
R&D (%)	The percentage of R&D spending to operating income	R&D spending/Operating income
Performance	ROA (Return on Asset) ROE (Return on Equity)	After-tax operating income/total average asset After-tax operating income/total average equity
DIFF	Dummy variable of firms adopting differentiation strategy (DIFF = 1, otherwise, = 0)	
LEAD	Dummy variable of firms adopting cost leadership strategy (LEAD = 1, otherwise, = 0)	
SIZE	Control variable of firm size	Log(total assets)
LEV	Control variable of leverage	Total liabilities/Total assets
SALES	Control variable of sales	Log(Operating revenue)
YEAR	Dummy variable controlling for year fixed effect	-
IND	Dummy variable controlling for industry fixed effect	-
PM	Profit margin	After-tax income/Sales
AT	Asset turnover	Sales/Average total assets

Identification of the strategic positions

The financial ratio analysis is applied following the study of Selling and Stickney [18] to identify firms' strategic positions. According to the research, the firms adopting a product differentiation strategy tend to produce unique products and differentiate themselves to obtain market share over revenues and profit margins. In contrast, companies with a cost leadership strategy aim to profitability by charging low prices and selling high volumes. Therefore, the differentiation strategy concentrates on increasing profit margins, while the cost leadership aims to improve asset turnover.

Table 3 reports the descriptive statistics and correlation matrix for the sample. In Panel A, the mean, standard deviation, and percentile values of each variable are showed. For the percentage of R&D spending to operating income, the mean and median values are 3.909 and 2.177, respectively. *ROA* has a mean of 0.084 and a median of 0.074. The mean values of PM (profit margin) and AT (asset turnover) are 0.106 and 0.835, respectively. Lastly, SIZE, LEV, and SALES have mean values of 15.395, 0.331, and 15.051, respectively. Panel B shows the correlation matrix of the variables. R&D (%) has a significantly positive relationship with *ROA* and PM but negatively correlates with AT, SIZE, LEV, and SALES.

Table 3

Descriptive statistics and correlation matrix

Variables	Mean	SD	5th Pctl.	25th Pctl.	Median	75th Pctl.	95th Pctl.
Panel A: Descriptive Statistics							
R&D (%)	3.909	5.141	0.000	0.662	2.177	4.811	14.628
ROA	0.084	0.066	0.003	0.042	0.074	0.118	0.203
PM	0.106	0.099	0.002	0.043	0.089	0.150	0.289
AT	0.835	0.529	0.271	0.492	0.730	1.013	1.819
SIZE	15.395	1.393	13.595	14.438	15.130	16.114	18.041
LEV	0.331	0.141	0.121	0.219	0.323	0.427	0.570
SALES	15.051	1.444	13.235	14.054	14.795	15.769	17.617

Panel B: Correlation Matrix							
	R&D (%)	ROA	PM	AT	SIZE	LEV	
ROA	0.085***						
PM	0.0715***	0.6862***					
AT	-0.1045***	0.1291***	-0.3488***				
SIZE	-0.1879***	-0.0238	0.1277***	-0.0368**			
LEV	-0.222***	-0.2624***	-0.2958***	0.2252***	0.1997***		
SALES	-0.2024***	0.0485***	-0.0418**	0.3208***	0.9197***	0.2711***	

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

Following their argument, two indicators are chosen to identify firms' strategic positions: profit margin and asset turnover.

Identify company strategic positions using financial ratios is widely applied in the literature [13, 21, 33]. Palepu, et al. [33] suggest that cost leaders may have relatively low-profit margins but high asset turnover in return, while the differentiators may generate high-profit margins but low asset turnover. In this paper, firms with higher profit margins and lower asset turnovers as those that adopt differentiation strategy, and vice versa, firms with lower profit margins and higher asset turnover adopt cost leadership strategy.

The profit margin is measured as after-tax operating income divided by sales (PM), and asset turnover is measured as sales divided by average total assets (AT).

The sorting of the sample to different strategy groups is highly critical as it may decide the research outcome. The sample is divided into nine deciles (quantiles) based on *ROA* in 2013 – each decile consists of 65 or 66 firms (Table 4). The first decile contains firms with the lowest *ROA*s, whereas decile 9 represents firms with the highest *ROA*s. Firms are again sorted based on asset turnover within each of these deciles: around eleven companies with the highest asset turnovers are selected as cost leaders, and another eleven firms with the lowest asset turnovers represent differentiators. So in total, there are 94 firms as differentiators (470 firm-year observations) and 99 firms as cost leaders (495 firm-year observations). Moreover, the control group is the test sample, which is not in the differentiators and cost leaders groups.

Table 4
Decile ranks of ROA in 2013

Decile rank	*ROA* (Min)	*ROA* (Max)	Length of Range	No. of Companies
1 (lowest *ROA*s)	-0.2184	0.0129	0.2313	66
2	0.0129	0.0304	0.0175	65
3	0.0309	0.0472	0.0163	66
4	0.0472	0.0616	0.0144	65
5	0.0618	0.0793	0.0176	66
6	0.0794	0.0992	0.0199	65
7	0.0995	0.1222	0.0227	66
8	0.1224	0.1575	0.0351	65
9 (highest *ROA*s)	0.1583	0.3227	0.1645	65

Sorting first based on *ROA* is necessary to eliminate biases that categorizing solely on asset turnover and profit margin. In Table 4, the length of each decile measured by *ROA* is different, and lengths may vary substantially. In deciles 2-8, the lowest and highest *ROA* differences are only 1.44% to 3.51%. Whereas for deciles 1 and 9, variation is the highest, the difference is 23.13% and 16.45%, respectively. Companies with extremely high or low *ROA*s may cause biases because they might act as outliners or leverage points.

Thus, to ensure that the sorting of samples is not causing biases for the results, a double sorting technique is necessary. Therefore, in addition to the first sorting based on *ROA*, the second sorting based on asset turnover of firms in 2013 is conducted. According to Dechow, et al. [34], the first sorting variable should have substantial variation while the second sorting variable stays relatively constant. This holds with the sample of this research.

In Table 5, when *ROA* is used for the initial ranking (Panel A), it has a high variation of 0.2257 (High-low). In contrast, *ROA* in the second sorting (Panel B) that uses asset turnover has a variation of only 0.0447. The same phenomenon can be seen with asset turnover in two different decile rankings. The comparison allows us to conclude that Panel A, the sorting method for this research, creates variation for *ROA* and keeps asset turnover relatively constant as it should. Furthermore, sorting in Panel A is better because differentiation, cost leadership, and the control groups all receive observations with high and low *ROA*s. Furthermore, it also holds valid with the *ROA* curve in Figure 1 that all levels of *ROA* can be achieved with different combinations of profit margin and asset turnover [18], therefore at different *ROA* levels, there would be both differentiators and cost leaders included.

Table 6 presents the mean and median values of AT, PM, and R&D for the differentiation and cost leadership strategy group. The cost leadership strategy has higher levels of AT, with the mean and median values of 1.6332 and 1.4858, respectively, and lower levels of PM, with the mean and median values as 0.0439 and 0.0387, respectively. On the other hand, differentiation strategy has higher levels of PM and lower levels of AT. This group's mean and median values are 0.2037 and 0.1933 for PM and 0.3501 and 0.3449 for AT. Furthermore, R&D (%) of firms adopting differentiation strategy is also higher than the cost leaders with the mean of 4.0047 and 2.3499 for median, while the mean and median values are 1.8714 and 1.0768 for cost leaders. These results are consistent with Hypothesis 1 that there is more R&D spending for firms adopting differentiation strategy than firms with cost leadership.

Table 5
Different decile ranking methods

Panel A: Decile ranking of *ROA* in 2013			
Decile Rank	*ROA* (mean)	AT (mean)	PM (mean)
1 (lowest *ROA*s)	-0.0203	0.8836	-0.0310
2	0.0220	0.7864	0.0298
3	0.0390	0.8285	0.0555
4	0.0547	0.9359	0.0682
5	0.0705	0.8157	0.1047
6	0.0884	0.9834	0.1055
7	0.1092	0.8609	0.1382
8	0.1376	1.0464	0.1456
9 (highest *ROA*s)	0.2054	1.1048	0.1915
High-low	**0.2257**	**0.3185**	**0.2224**
Panel B: Decile ranking of asset turnover (AT) in 2013			
Decile Rank	AT (mean)	*ROA* (mean)	PM (mean)
1 (lowest ATs)	0.2754	0.0504	0.1686
2	0.4146	0.0639	0.1304
3	0.5182	0.0678	0.1097
4	0.6273	0.0641	0.0873
5	0.7273	0.0776	0.0903
6	0.8383	0.0945	0.0948
7	0.9774	0.0878	0.0767
8	1.1761	0.0821	0.0580
9 (highest ATs)	1.9548	0.0951	0.0443
High-low	**1.6794**	**0.0447**	**0.1243**

Table 6
Descriptive statistic of different strategy groups

Cost Leadership Strategy			**Differentiation Strategy**		
	Mean	Median		Mean	Median
PM	0.0439	0.0387	PM	0.2037	0.1933
AT	1.6332	1.4858	AT	0.3501	0.3449
R&D (%)	1.8714	1.0768	R&D (%)	4.0047	2.3499
No. of Obs.	495		No. of Obs.	470	

MODELS

The research uses STATA and ordinary least squares (OLS) regressions to test the hypothesis. The regression model for hypothesis 1 includes two dummy variables to test the effect of different strategies. One is *DIFF*, with equals 1 if the firm adopts a differentiation strategy and 0 otherwise. The other is *LEAD*, which equals 1 if the firm adopts cost leadership and 0 otherwise. The following regression model is estimated using all observations:

$$R\&D(\%) = \beta_0 + \beta_1 DIFF + \beta_2 LEAD + \sum_k \gamma_k Control^k + Year + Ind + \varepsilon \quad (1)$$

where:

R&D (%) – the percentage of R&D spending to operating income

Control variables:

SIZE – log of total assets

LEV – total liabilities divided by total assets

Year and *Ind* are year and industry dummies controlling for year and industry fixed effects.

If the coefficient of DIFF is significantly positive while LEAD is significantly negative, Hypothesis 1 would be strongly supported, which means firms with differentiation strategy intend to spend more on R&D activities and firms adopting cost leadership strategy intend to spend less. It is also predicted that the coefficient of SIZE to be pessimistic given the sizeable economic scale, and the ratio of R&D expenditure to operating income is used instead of the total amount to measure the intensity of R&D spending. Additionally, the coefficient of LEV is also predicted to be negative with R&D spending because a firm with higher leverage has less freedom to invest in R&D.

For the second and third Hypotheses, the following regression model is conducted using the subsample of firms with differentiation or cost leadership strategy, respectively.

$$Performance = \beta_0 + \beta_1 R\&D(\%) + \beta_2 R\&D(\%)^2 + \sum_k \gamma_k Control^k + Year + Ind + \varepsilon \quad (2)$$

Where performance is ROA measured as the ratio of net profit to average total assets. The inclusion of R & R&D (%) and its fair value into the regression test whether there is a non-linear relationship. Control denotes SIZE, LEV and SALES, which is the log of operating revenue. Using SIZE, LEV as control variables in the model is widely applied in the literature (Guo et al., 2018). There are also dummies year and industry for controlling fixed effects. For the firms adopting differentiation strategy, it is expected that there is a linear relationship between R&D expenditure and performance, which means the coefficient of R&D (%) to be significantly positive, and the coefficient of R&D (%)2 to be insignificant. On the other hand, firms with a cost leadership strategy is expected to have a positive correlation with R&D (%) and a negative correlation with R&D (%)2. Indicating an inverted U-shape between R&D spending and performance.

EMPIRICAL FINDINGS

Effect of strategic position on R&D spending

Table 7 reports the regression analysis results of R&D spending as the dependent variable and dummies of strategic positions (DIFF = 1, LEAD = 0 for firms adopting differentiation strategy and otherwise for firms with cost leadership strategy) and other control variables (SIZE, LEV). The other two dummies, YEAR and IND, are included in the regression model of columns (2) and (4) to control for fixed effects. There are four different regression models in Table 7 divided into four columns from (1) to (4). Columns (1) and (2) report the results of the full sample (2,944 observations) to test the effect of strategic positions on R&D spending. In the first column, the results are insignificant without the industry and year fixed effects. When the fixed effects of those two dummies are controlled, the results in column (2) are consistent with hypothesis 1. It shows that the coefficient of DIFF is significantly positive with R&D spending, whereas the coefficient of LEAD is significantly negative, which means that companies pursuing differentiation strategy are likely to have higher R&D spending than firms adopting cost leadership strategy.

The coefficient of DIFF with year and industry fixed effects is 0.5654 at 5% significant level, and it is -1.7056 at 1% significant level for the coefficient of LEAD. In addition, we can see that SIZE has a negative relationship with R&D expenditure with the negative coefficients of -0.5200 and -0.5789 in columns (1) and (2), respectively and both are significant, which indicates that larger firms have a lower percentage of R&D spending to operating income. LEV also has a significantly negative coefficient of -6.0946 in column (1) and -3.6731 in column (2), meaning that firms with higher leverage have lower R&D spending, i.e. companies which have higher liabilities would have lower spending on R&D activities.

Table 7
Regression analysis of R&D spending for firms with different strategies

	If R&D (%) > 0			
	(1) Coef./t	(2) Coef./t	(3) Coef./t	(4) Coef./t
DIFF	-0.2469	0.5654**	-.0997	0.7436***
	(-0.94)	(2.54)	(-0.35)	(3.08)
LEAD	-1.8604***	-1.7056***	-1.7557***	-1.9118***
	(-7.38)	(-7.97)	(-6.25)	(-8.01)
SIZE	-0.5200***	-0.5789***	-0.5159***	-0.6217***
	(-7.61)	(-9.88)	(-6.88)	(-9.60)
LEV	-6.0946***	-3.6731***	-7.1137***	-4.1730***
	(-9.01)	(-6.36)	(-9.71)	(-6.68)
_cons	14.2818***	12.0901***	14.9709***	15.0924***
	(14.02)	(7.54)	(13.46)	(7.78)
YEAR	No	Yes	No	Yes
IND	No	Yes	No	Yes
R-squared	0.0877	0.3973	0.0942	0.3952
No. of obs	2,944	2,944	2,616	2,616

Note: This table shows the regression results of R&D spending on different strategies and other control variables. Year (YEAR) and Industry (IND) dummies are included to control for fixed effects in columns (2) and (4). The subsample with positive R&D is used in columns (3) and (4) to make the result more reliable. T-statistics are reported in the parentheses.
*Coefficients marked ***, ** and * are significance at the 1%, 5% and 10% levels, respectivel.*

In order to make the results more reliable, the regression models using a subsample of positive R&D spending are shown in columns (3) and (4). The number of observations in these two regressions is reduced from 2,944 to 2,616 compared to the former. The results remain robust. As same as the results in columns (1) and (2), though the results in column (3) are insignificant without the controlling YEAR and IND for fixed effects, we can find that the coefficients of DIFF and LEAD are significant at 1% level of 0.7436 and -1.9118 respectively. This result is also consistent with hypothesis 1.

Effect of R&D spending on firm performance conditional on generic strategy

This section reports the results exploring the relationship between R&D spending and firm performance conditional on strategic positions. The regression results are showed in Table 8. To process the analysis, the sample of firms adopting differentiation strategy is conducted in Panel A. The following is the sample of firms with cost leadership strategy in Panel B. Firm performance is measured by ROA as the dependable variable in the regression. However, to make

the results more reliable, regressions with *ROE* (Return on Equity) as a measurement of firm performance are also included in the analysis as a double-check. As aforementioned, the squared value of R&D (%) will be put in regression (2) and (4) to test whether the relationship is U-shaped.

In Panel A, for the firms with a differentiation strategy, performance is positively associated with R&D spending. In columns (1) and (3), the coefficient of R&D (%) is 0.0010 for *ROA* and 0.0013 for *ROE*. Both the coefficients for *ROA* and *ROE* are significant at the 10% level, which means that R&D spending positively affects firm performance when adopting differentiation strategy and supporting hypothesis 2. In columns (2) and (4), where the U-shaped relationship is tested, the coefficients of R&D $(\%)^2$ for firm performance are all insignificant, indicating their relationships are not U-shaped. For the control variables, SIZE has a significantly negative coefficient for *ROA* and *ROE*, indicating that smaller firms can achieve better performance. LEV also has a significantly negative relationship with *ROA*, meaning the firms with higher leverage perform worse. SALES is positively associated with *ROA* and *ROE*, and it is evident that the more sales volume, the better the firm performance. Overall, the results show that the higher the R&D spending, the better the performance of firms adopting differentiation strategy, supporting hypothesis 2.

At the bottom of Table 8, the regression results for firms adopting cost leadership strategies are presented in Panel B. Although the regressions (1) and (3) report that the coefficient of R&D (%) is significantly positive with both *ROA* and *ROE*, when we look at the column (2) and (4), $R\&D^2$ (%) has a negative relationship with both *ROA* (-0.0007) and *ROE* (-0.0011) with a significant level of 5% and 10%, respectively. It means that the relationship between R&D spending and firm performance has an inverted U-shape. In other words, when the level of R&D expenditure is low, increasing it would help improve the cost leaders' *ROA* and *ROE*. However, the *ROA* and *ROE* would decrease with more R&D spending when its level is already high. For the control variables, *SIZE* has a significantly negative coefficient for *ROA* and *ROE*, indicating that smaller firms can achieve better performance. *LEV* also has a significantly negative relationship with *ROA*, meaning the firms with higher leverage perform worse. *SALES* is positively associated with *ROA* and *ROE*, which has similar results with Panel A. Overall, two of the performance measurements show consistent results supporting hypothesis 3.

Then I would like to check the breakpoint of the inverted U-shape to explore if the companies with cost leadership strategies have good R&D spending.

The results show that the breakpoint of R&D (%) for *ROA* is 7.165 and 7.466 for *ROE*. It means that cost leaders have the highest level of firm performance when R&D (%) is around 7 to 8 when other factors are properly controlled. However, Table 9 reports that the 95th percentile of R&D (%) for the cost leadership subsample is 6.623, and the 99th percentile is 11.577, which indicates that most firms have less R&D expenditure than the appropriate level in practice according to the results. In practice, manufacturing companies will stop spending on R&D activities when they feel that the costs exceed the benefit of innovation.

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

	Panel A: Differentiation Strategy			
	ROA (1)	*ROA* (2)	*ROE* (3)	*ROE* (4)
R&D (%)	0.0010*	0.0018	0.0013*	0.0031*
	(1.87)	(1.53)	(1.93)	(1.78)
R&D^2 (%)		-0.00003		-0.00006
		(-0.84)		(-1.08)
SIZE	-0.0685***	-0.0682***	-0.0875***	-0.0870***
	(-9.03)	(-8.98)	(-8.00)	(-7.95)
LEV	-0.1347***	-0.1333***	-0.0024	0.00004
	(-6.71)	(-6.62)	(-0.08)	(0.00)
SALES	0.0768***	0.0763***	0.0987***	0.0978***
	(10.32)	(10.21)	(9.20)	(9.08)
_cons	0.0167	0.0194	-0.0099	-0.0048
	(0.46)	(0.53)	(-0.19)	(-0.09)
Year	Yes	Yes	Yes	Yes
Ind	Yes	Yes	Yes	Yes
R-squared	0.3667	0.3677	0.2917	0.2936
No. of obs	469	469	469	469
	Panel B: Cost leadership strategy			
	ROA (1)	*ROA* (2)	*ROE* (3)	*ROE* (4)
R&D (%)	0.0031**	0.0095***	0.0056**	0.0159***
	(2.11)	(2.66)	(2.25)	(2.62)
R&D^2 (%)		-0.0007**		-0.0011*
		(-1.98)		(-1.86)
SIZE	-0.0536***	-0.0575***	-0.0833***	-0.0896***
	(-6.34)	(-6.64)	(-5.80)	(-6.09)
LEV	-0.1525***	-0.1497***	-0.0528	-0.0483
	(-6.59)	(-6.47)	(-1.34)	(-1.23)
SALES	0.0526***	0.0564***	0.0812***	0.0873***
	(6.42)	(6.72)	(5.84)	(6.12)
_cons	0.0858***	0.0845**	0.0782	0.0761
	(2.39)	(2.36)	(1.28)	(1.25)
Year	Yes	Yes	Yes	Yes
Ind	Yes	Yes	Yes	Yes
R-squared	0.2691	0.2751	0.1876	0.1935
No. of obs	494	494	494	494

*Note: This table shows the regression results of firm performance on R&D spending and its squared value for the firms with differentiation and cost leadership strategies. Panel A reports the results of firms adopting differentiation strategy, and Panel B is for companies with cost leadership strategies. T-statistics are reported in the parentheses. Coefficients marked ***, ** and * are significance at the 1%, 5% and 10% levels, respectively.*

Therefore, these companies are pretty conservative in R&D spending as the cost leaders in the industry.

Table 9
Descriptive statistic of cost leaders subsample

Variables	**1st Pctl.**	**5th Pctl.**	**25th Pctl.**	**Median**	**75th Pctl.**	**95th Pctl.**	**99th Pctl.**
R&D (%)	0.000	0.000	0.165	1.077	2.777	6.623	11.577

Note: This table reports the descriptive statistic of R&D (%) for firms that adopt cost leadership strategy.

DISCUSSION

The purpose of this paper is to explore the relationship between R&D spending and firm performance conditional on corporate strategic positions, which is also known as the internal generic strategy, with the evidence from manufacturing firms in Taiwan. For that purpose, this research emphasises the role that a manager's initiative plays in the effect of R&D spending on firm performance. The data was collected from TEJ database with 5-year period financial data of 597 manufacturing firms in Taiwan.

H1: There is more R&D spending by firms adopting differentiation strategy than those with cost leadership strategy.

The first hypothesis was to explore the level of R&D expenditure of firms that adopt different strategic positions. For firms adopting a product differentiation strategy, extensive spending on R&D is necessary to maintain their competitive advantages with the uniqueness of a product or service and generate a high profit margin. In contrast, the focus is more on controlling costs for firms that adopt a cost leadership strategy. Therefore, R&D expenditure and product innovation are not their core competitive advantages. R&D spending is usually tightly controlled to minimise cost. The descriptive statistic supports this hypothesis as there is more R&D spending for firms adopting differentiation strategy than firms with cost leadership. Then come to the first regression model with R&D (%) as the dependent variable, the coefficients of differentiator and cost leader dummy variables are significantly positive and negative, respectively. Firms with differentiation strategies have more R&D spending than firms adopting cost leadership strategy, and hypothesis 1 is strongly supported.

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

The second hypothesis examined the effect of R&D expenditure on firm performance for firms adopting a product differentiation strategy. As unique products are the aim of these companies, which makes them different from low-cost competitors and the threat of imitations, high R&D spending is critical. The results show that R&D (%) has a significant positive relationship with ROA and ROE, which means that firms that adopt differentiation strategy will have higher performance if they increase R&D spending. Hence, hypothesis 2 is supported.

H3: If firms adopt cost leadership, R&D spending would have an inverted U-shaped relationship with the firm's performance.

This hypothesis checked the relationship between R&D spending and firm performance for firms with cost leadership strategies. Cost leadership emphasises efficiency, whereas proper R&D expenditure is needed to improve efficiency. It can help design manufactured products more efficiently, reduce product material costs, and optimise producing procedures. However, the overutilisation of R&D costs is against the principle of cost leadership strategy. Firstly, it conflicts with the strategy of reducing the cost to provide low-price products. Secondly, it is impossible to manufacture on a large scale all new products resulted from R&D activities. For firms that adopt a cost leadership strategy, efficient R&D spending can lead to the best performance. Therefore, the level of R&D spending for cost leaders should be reasonable. The results report that R&D spending has an inverted U-shaped relationship with the performance of firms with cost leadership strategy. Therefore hypothesis 3 is also supported.

With these results, the central questions of this research are: "*Do firms within an industry with different strategic positions have different levels of R&D spending? What are the effects of R&D spending on firm performance conditional on different strategic positions?*" Indeed, firms within an industry may have different levels of R&D spending depend on their strategic positions. More precisely, firms adopting a differentiation strategy would have more R&D spending than firms with a cost leadership strategy. Secondly, the higher level of R&D spending, the higher the performance for firms with a differentiation strategy. For companies that adopt a cost leadership strategy, the relationship forms an inverted U-shape.

As R&D becomes more and more important for every manufacturing firm in the world and Taiwanese firms, in particular, this research provides a better understanding of the effect of generic strategy on R&D spending and the effect of R&D spending on firm performance conditional on different strategic positions. This paper contributes to providing a practical suggestion for manufacturing firms in Taiwan on how to allocate their resources wisely and efficiently according to their strategies. As for firms adopting the differentiation strategy, R&D spending is vital to maintain competitive advantages: uniqueness of products/services, advanced technology, innovation, and good customer care. Therefore, the investment in R&D is critical. Moreover, the performance of these firms will increase more if they invest in R&D spending more. For firms with a cost-leadership strategy, R&D spending is also essential in order to improve efficiency. However, they should allocate the budgets wisely and reasonably, as controlling cost is the main focus of this strategy to keep their competitive advantages.

Last but not least, we have not considered some aspects such as the company life cycles or the effect of liability leverage to ROE or the funding resources of the R&D activities. Therefore, for further researches related to this topic in the future, we suggest researchers should take into account those factors and develop even deeper research and study into the topic.

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