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Differentiation Strategy, R&D Intensity, and Sustainability of Accounting Earnings: With a Focus on Biotech Firms

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Abstract: In this paper, we examine the association between management strategy and a firm’s sustainability of accounting earnings over almost 20,000 firm-year observations in South Korea between 2000 and 2017. Using the differentiation strategy developed by Porter for measuring management strategy, we find that firms that implement the differentiation strategy make more-sustainable accounting earnings, as measured by the persistence of return on assets. In addition, regardless of the magnitude of R&D investments, proper implementation of the differentiation strategy is positively associated with the sustainability of accounting outcomes. However, except when sales increase, a reduction in R&D intensity has a negative impact on the persistence of accounting income for biotech firms. This is because biotech firms are not be able to continue to strengthen core competencies and thus cannot ultimately implement a differentiating strategy effectively.

Keywords: differentiation strategy; R&D intensity; biotech firms; sustainability of accounting earnings

1. Introduction

This study examines the impact of differentiation strategy on sustainability of accounting earnings [1,2]. In order to adapt effectively to changes in the global business environment, firms must choose an optimal strategy. Firms need to flexibly set up strategies according to changes regarding technology, competition, regulations, and so on. They must also effectively distribute and regulate internal resources. According to a report from the Brookings Institute regarding listed companies in the US in 1982, the book value of tangible assets was around 62% of the market value. However, it is estimated to have lowered to 38% in 1992, and recently to 10–15%. This could be an indirect implication that intangible assets are increasing in value [3]. Considering the rise of intangible assets, such as new technology, intellectual property, brand value, employee competence, flexible processing, and customer relations, it can be seen that firms’ strategies need to be established with higher innovation and differentiation [3,4].

Today, technological innovation is often mentioned as an irreplaceable factor for sustainable economic development, long-term survival of a firm, and for raising society-wide quality of life. As such, nations around the world, whether developed or developing, are investing massive resources in technological innovation. This trend has stoked intense competition between companies, countries, and regions. Such perceptions are also shown by recent active social scientific studies on technological innovation and R&D investments of companies in developed nations.

South Korea selected promising future industries based on the national innovation system and technology innovation clusters from the early 2000s, and have focused corporate R&D investments in these fields. Among these, biotech firms, along with electrical and electronic firms, are perceived...
as a growing power for Korea’s future generation. Recently, the government and private sectors have rapidly been increasing such R&D investments. Specifically, a survey of 980 Korean biotech companies by the Korea Bio Association showed that the total corporate investment in 2016 was 1.956 trillion won, of which R&D activities accounted for 67.3% and facility investment accounted for 32.7%. Investment in R&D rose 0.6% annually, and facility investment costs increased sharply to 56.1% due to the expansion of production plants by large companies’ R&D activities.

However, the current rate of progress in Korea’s biotech firms is seen to be lower than that of the US, Europe, and Japan. Recently, biotech companies in developing nations such as China and India are on the verge of surpassing biotech companies in Korea. In fact, the development of biotech firms will not end up as academic progress, but will lead to a national strategy that directly links to and maximizes all the interests of the country, including trade, the national economy, and the environment, and will form an international network. In addition, for the sustainable flow of innovation, which is the driving force of the biotech firms, new technologies and new knowledge that must be continuously supplied, and R&D investment and policy support should be expanded. For this reason, there is a need to closely analyze the achievements and conditions of government and private R&D put into biotech firms through academic perspectives. R&D characteristics and the commercialization processes of biotech firms have exceptionally different economic features in comparison to other industries (such as electronics or machine industries). Therefore, it is valuable to investigate whether the effect of management strategies on the sustainable flow of innovation differs between biotech firms and non-biotech firms.

This paper investigates how management strategies affect the sustainability and persistence of firms’ accounting earnings in the Korean capital market, placing a focus on biotech firms, which are leaders in the knowledge economy era. If differences can be found between biotech and non-biotech firms regarding the relationship between management strategy and firms’ sustainability of accounting earnings, we could conceivably improve the value of a firm through implementing appropriate management strategies. The primary findings of the paper are as follows: First, we find a positive relationship between implementing a management strategy while considering the internal and external environment and future sustainability of accounting earnings. Second, the paper documents how appropriately applying a differentiation strategy significantly affects the sustainability of accounting outcomes, even when reducing R&D investments. Finally, for biotech firms that hold R&D investment as the key differentiation strategy, the impact on future sustainability of accounting earnings is observed to be influenced by R&D intensity. Ultimately, this study finds that the differentiation strategy improves the overall sustainability of accounting earnings.

This paper contributes to prior studies in the following ways: First, it provides further evidence on the consequences of implementing management strategy by investigating the persistence of accounting earnings of Korean firms. The effects of management strategy on the sustainable performance of firms is just one of the research topics that have received much attention in the field of management strategies [1,2,5]. However, this is the first time that a convergence study linking management strategy and sustainable performance measurement has been attempted in the field of accounting. Specifically, this paper utilizes Porter’s competitive advantage model as the proxy variable for the management strategy [1,2]. Porter’s competitive advantage model provided us with management strategies following market area and comparative advantage, and demonstrated that firms that establish one suitable management strategy consistently bring high outcomes [5].

Second, this study intends to measure sustainability properly using a flow variable, the persistence of accounting earnings. According to Wikipedia, economics, business, accounting, and related fields often distinguish between quantities that are stocks and those that are flows. These differ in their units of measurement. Specifically, a stock is measured at one specific time, and represents a quantity existing at that point that may have accumulated in the past. However, a flow variable is measured over an interval of time. In this sense, specific time measures such as earnings, financial ratios, and market value would not represent a flow concept. For example, accounting earnings can be manipulated...
temporarily by deferring revenues and accruing expenses. These instantly deteriorated earnings reverse in subsequent years, decreasing the sustainability of earnings. In this regard, if performance measure is applied based on the stock concept, investors temporarily overestimate the sustainable performance of issuing firms, and consequently are frustrated by the decrease in earnings due to misapplication of the performance measure. Therefore, the persistence of accounting earnings is more sustainable due to the fact that it has little space for the intentional manipulation of financial statements.

Finally, the findings in this paper could improve policymaking for biotech firms. In detail, the large R&D expenses in biotech firms are expected to provide a utility in the future. However, they consume significant corporate resources in the present. Also, there is always the difficulty of ensuring that information users or policymakers evaluate these R&D expenses objectively and provide accurate financial information, as R&D spending is not tangibly recognized and not subject to well-defined standards of measurement and disclosure. While a positive association between R&D activity and a firm’s future profitability is consistent with the value-enhancing impact of innovation, it is not obvious whether capital providers properly estimate the contribution of the interaction between management strategy and R&D expenses to sustainability of accounting performance for biotech firms. Thus, the results of this research will provide practical help in understanding these problems.

This paper is organized as follows: Section 2 mentions the theoretical background and presents the hypotheses. Section 3 explains the research design and the process of the sample selection. Section 4 provides the empirical results. Section 5 concludes.

2. Related Research and Hypothesis Development

Management strategies are the plans and policies of firms to achieve a goal; they explain how firms handle changes to the external environment and compete with other firms. It is a concept covering product, market, and organizational structure, as well as ways to cope with both internal and external uncertainty. Originally a military term, it was adopted into business administration for scholars presenting various strategy alternatives for firms. Prominent theoretical studies of management strategy include Porter [1], March [6], and Miles and Snow [7].

Porter [1] proposed the generic strategy of cost leadership and product differentiation strategy. March [6] presented basic types of strategies based on knowledge for effectively developing a knowledge base: (1) exploration, emphasizing the creation and acquisition of new knowledge; and (2) exploitation, focused on raising the utilization ability of current knowledge. Miles and Snow [7] focused on the continuum concept and classified three strategy types: prospector, defender, and analyzer. They also constructed a strategy index (SI) to generally apply strategies to various industries. Among these, Porter’s strategy types are known to be useful, as the classification is comprehensive and precise without ambiguity. Also, Porter’s strategy types appear to correlate with those of Miles and Snow [7]. The validity is acknowledged as the representative variable for competitive strategy [8]. Furthermore, the competitive strategy by Porter [1] is detailed and clear in concept, evidenced by its wide application regardless of environmental factors or national or industry characteristics. This study also used product differentiation strategy as the proxy of management strategy.

Product differentiation strategy means creating something that enables a firm’s product or service to be distinct within the industry [8–12]. There are several methods to accomplish this differentiation strategy, such as using design images and logos, creating a unique product trait through R&D, using customer-facing services, using a robust sales network, and so on. Firms that pursue a differentiation strategy tend to set prices high, so production cost spent on implementing the differentiation strategy is shifted on the customers.

Observing previous studies in accounting that used management strategy as the key variable, Ittner et al. [13] investigated how management strategy impacts the financial and nonfinancial index for evaluating outcomes of managerial compensation contracts. Bentley et al. [14] analyzed the influence of management strategy on financial reporting irregularities (reports on violation, rewriting the financial statement, litigation, etc.). Moreover, Horngren et al. [15] used the operating income analysis model
to analyze the relationship between management strategy and accounting income. They concluded that when pursuing product differentiation strategy, operating income is related to the increased price effect (price compensation factor). This implies that firms can increase accounting outcomes through a product differentiation strategy by the amplified effect of price changes.

As differentiation strategy aims at innovation, high performance, and high quality products through intensive investment in R&D, allowing firms a durable competitive advantage, it is difficult for competitors to easily imitate [16]. Among the factors used to implement differentiation strategy, technology competence through R&D investment can be one of the most important sources of sustainable competitive advantage [17]. Guo et al. [18] examined the relationship between R&D spending and future performance. They found a positive association between R&D spending and future performance for firms adopting a differentiation strategy, but found an inversed U-shape relationship for firms adopting a cost leadership strategy.

Prior studies in accounting have also explored the impact of R&D spending on future performance. Most of this literature finds that R&D investment has a positive effect on a firm’s performance [19–21]. In particular, Banker et al. [22] examined how firms could achieve higher outcome on Return on Asset (ROA) and Operating Cash Flow (CFO) by implementing cost leadership and product differentiation strategies. They concluded that firms that chose a differentiation strategy had greater sustainability in their performance compared to cost leadership. In addition, Zajac et al. [23] reported that in situations in which changes in corporate strategy are necessary, entities that implement changes in strategy to conform to the environment (i.e., those with strategic suitability) produce excellent management performance. Sandberg et al. [24] also studied the relationship between competitive strategies and corporate performance for venture companies, and reported that different types of strategies selected by the company showed differentiated performance, while Venkatraman and Ramanujam [25] analyzed the relationship between strategy and performance by dividing management performance into three major categories (theoretical, empirical, and financial).

In fact, the interpretation of managerial performance in the preceding studies varies among scholars. For example, Adam [26] divided management performance into operational performance and financial performance, while Ahire et al. [27] intended to measure management performance primarily in terms of product-related characteristics, such as product performance, reliability, consistency, durability, and rework ratio. However, for accurate measurements of the effect of implementing management strategy on a firm, it is more appropriate to measure the sustainable performance rather than short-term performance, so this study focuses on measuring the long-term effects of differentiation strategy by measuring the persistence of accounting income as a proxy for performance. The first hypothesis is as follows.

**Hypothesis (H1).** Firms’ differentiation strategies will positively impact future performance sustainability.

In the process of applying differentiation strategy, firms’ decision-making about R&D intensity can vary depending on the circumstances. When firms increase investment in R&D, cash outflows inevitably occur. Therefore, companies may reduce their R&D investment for financial constraints, earnings’ management purposes, or for other strategic reasons. A firm’s amount of surplus money most importantly affects the firm’s discretionary decisions for the investment [28–31]. To be more precise, financially distressed firms are likely to decrease, or at least delay investment [31–35]. Firms’ decision-making regarding investments can also be affected by earnings management purposes by avoiding recognition of R&D spending as expenses [36]. Moreover, firms can discretionarily cut R&D spending for actual business activity manipulation [37–39].

Growing firms tend to implement more-aggressive differentiation strategies to pioneer a new market or increase their current market share. Aggressive differentiation strategy does not only cover facility investments, but also labor force adjustments, advertising expenses, sales commissions, and R&D intensity. Managers may carry out this differentiation strategy by increasing or decreasing the investment of resources for the pursuit of self-interest and short-term performance, or they could
apply it to achieve sustainable and long-term growth for the firm regardless of time spent. Using this value, investing would depend on the manager’s tendency to implement strategies. That is, when making decisions on investment for implementing the differentiation strategy, the investment level would be decided similarly to other investments—that is, managements consider the given investment opportunity, as well as the internal and external situation of the firm. Therefore, R&D intensity may be reduced at the discretion of managers in carrying out aggressive differentiation strategies. Accordingly, the following assumptions are established in this study, predicting that even if the R&D investment decreases, the differentiation strategy will not differ in the persistence of accounting income.

Hypothesis (H2). An R&D intensity decrease will not negatively impact the association between a firm’s differentiation strategy and future performance sustainability.

The impact of a firm’s differentiation strategy on the persistence of accounting income is likely to differ by industry. Every firm makes essential decisions based on the resources they encompass while adjusting to internal and external environment factors. A firm’s management strategy is a crucial decision. Product differentiation strategy aims to achieve high prices by providing the customer a product that is distinguished from competing products. As such, the firm needs to identify a specific characteristic of the product that the customer regards as especially important, and then provide its characteristics. Continuous R&D investment, superior manufacturing technology, and marketing competence are needed to accomplish such a differentiation strategy. Thus, for biotech firms, most of the key activities in carrying out differentiating strategies are structured in R&D investments, which differentiate them from other industries.

According to Liebeskind et al. [40], the biotech industry is a typical knowledge industry, with sharp competition and an importance on the abilities for technological innovation. It has the characteristics of hypercompetition, uncertainty, appropriation problems, and intellectual resources. To be more specific, even if enormous investments are poured in, it is extremely difficult to predict investment influence on the final outcome. Also, the comparative advantage cannot hold long if there is no rapid and continuous technological innovation. Attaining intellectual property rights and key intellectual resources can be regarded as the critical factors for sustainable growth.

In addition, the cumulative innovation of inventions of the bio industry are lower than that of electrical and electronic areas. Thus, bio industry innovations have a relatively long technology lifespan compared to electronic industries. Even though the longest patent period for electrical and electronic industries is 20 years, the speed of technological development is so much faster that there are frequent cases where the actual patent period finishes earlier. However, bio pharmaceutical industries have a relatively long patent period because production of a new medicine entails a relatively long process of verification through clinical tests. Due to these traits, while electronic industries have a short technological lifespan that enables competing firms to catch up, it is difficult for bio industries to catch up or leapfrog, since firms that enter the market first, or those that preempt a certain area, gain lengthy continuing market power. This characteristic of the bio industry makes patent protection and intellectual property rights profoundly important compared to other industries, and for this reason R&D investment underlying intellectual property rights is crucial for biotech firms.

In the view of R&D costs, the process of R&D in bio industries has high uncertainty and risks of failure while it takes an extended period of time for the finished product to finally come out. According to the literature, the bio industry has a characteristic of being a “discrete product technology” where one technological innovation leads to the making of only one new product [41]. This gives products the strong characteristic of being a “single innovation”, but they usually cannot be complemented by other technologies. As for complex product technologies, such as electrical electronics or machines, even if a certain inventor achieves technological innovation, the commercial value of the invention has a high chance of being uncertain or undervalued if there are no innovations of other technologies that can complement it. They rely on the development of complementary technologies.
Generally, biotech firms that select a product differentiation strategy rely heavily on technology. The superiority of the technology acts as a critical factor for the survival and sustainable growth of the biotech firm. Since R&D is vital for advancing technology, biotech firms place a priority on continuously making R&D investment plans at the appropriate time and allocating adequate R&D expenditures. These firms that choose product differentiation strategy pursue sustainable growth in the future by differentiating their products. The essential business activity is to accomplish technological innovation by creating a new product, or by upgrading the original product’s abilities or design [42]. Therefore, since these firms’ core business activity is R&D, the activity’s importance is larger than that of firms using other management strategies [9].

Future sustainable profitability is prone to expand when management strategies combine well with management core activities that implement these strategies. Since R&D investment is the main activity of biotech firms, they would put more attention on it than non-biotech firms from the R&D planning stage to the implementation stage. In addition, biotech firms that select a product differentiation strategy put in a relatively large scale of R&D investment, which enables them to achieve economies of scale. They can also proceed with various R&D activities and reduce the overall risk of R&D by diversifying investments using their portfolio. Furthermore, firms that use a product differentiation strategy provide distinctive products and services that lead them to reach a higher premium pricing power (gross margin/sales) compared to non-biotech firms [43].

In sum, since the core activity of a biotech firm is sustainable technology development through R&D investment, the impact of differentiating strategies on the persistence of accounting income can be expected to vary depending on R&D intensity. According to a study on Australian firms by Chan et al. [44], the lower the degree of intensity of R&D in a firm, the lower their risk-adjusted return rate was in the future. Amir et al. [45] conducted research on the relationship between R&D investment and earnings volatility, and found that R&D expenses influenced earnings volatility only in firms with a high degree of intensity in R&D. Consequently, this paper predicts that in the case of biotech firms having a high degree of intensity in R&D, the effects of differentiation strategy on future sustainable outcome, depending on the intensity of R&D spending, would differ from that of non-biotech firms. In other words, a reduction in R&D intensity will have a negative impact on the persistence of accounting income for biotech firms because it will not continue to strengthen core competencies, nor, ultimately, implement a differentiating strategy effectively.

Since R&D intensity can then be subdivided into R&D spending and sales, this study establishes the following hypotheses:

Hypothesis (H3a). Unlike other industries, R&D intensity decrease will negatively impact the association between biotech firms’ differentiation strategy and future performance sustainability.

Hypothesis (H3b). Even in cases where R&D intensity decreases, if sales increase then the R&D intensity decrease will not negatively impact the association between biotech firms’ differentiation strategy and future performance sustainability.

3. Research Design

3.1. Sample Selection

This research uses data from the Korea Investors Service, Inc., and chooses 2000–2017 as the sample period. The sample includes publicly traded firms on the Korean Stock Exchange having a fiscal year-end of 31 December, but firms in the financial industries are excluded. All continuous variables are winsorized at the top 1% and bottom 1%. The final sample consists of 19,749 firm-year observations, with 8.44% of the sample firms being biopharma or biotech firms. Table 1 below presents sample distribution by industry.
Table 1. Sample distribution by industry.

| Industry                                      | Number of Firms | Years | %     |
|----------------------------------------------|-----------------|-------|-------|
| Agriculture/Fishing/Forestry/Mining          | 106             | 0.54  |
| Manufacturing                                | 11,145          | 56.43 |
| Electricity/Environment/Water supply         | 197             | 1.00  |
| Construction                                 | 828             | 4.19  |
| Retail/Wholesale                             | 1544            | 7.82  |
| Transportation/Warehousing                   | 378             | 1.91  |
| Lodging/Restaurants                          | 7               | 0.04  |
| Broadcasting/Communication/Publication       | 1290            | 6.53  |
| Computer/Information/Medical                 | 535             | 2.71  |
| Leasing/Real Estate/Renting                  | 55              | 0.28  |
| Biopharma/Biotech                            | 1667            | 8.44  |
| Others                                       | 1997            | 10.11 |
| Total                                        | 19,749          | 100.00|

3.2. Regression Model and Measurement of Variables

To examine Hypothesis 1, the following Ordinary Least Squares (OLS) regression model is used:

\[
\text{PERSROA}_{i,t+1} = \alpha + \beta_1 \text{DIFFROA}_{i,t} + \sum \alpha_j X_j + \sum \alpha_k \text{IND}_k + \sum \alpha_l \text{YEAR}_l + \epsilon_{i,t}
\]

where \(\text{PERSROA}_{i,t+1}\) is persistence of return on asset (ROA), which is a proxy for future performance sustainability. To measure \(\text{PERSROA}_{i,t+1}\), we ran the following regression model and took the coefficient \(\beta_1\) as the measure of persistence of ROA. ROA is measured as net income divided by total assets.

\[
\text{ROA}_{i,t+1} = \alpha + \beta_1 \text{ROA}_{i,t} + \epsilon_{i,t}
\]

DIFF refers to the differentiation strategy introduced by Porter [1,2], which is determined by individual factor scores. DIFFROA is the interaction between DIFF and ROA. To proxy the differentiation strategy, we selected the following four strategy variables with reference to variables used in previous studies:

1. selling, general, and administrative (SG&A) expenses ratio (SG&A expenses divided by sales);
2. total cost ratio (the sum of the cost of goods sold and selling, general, and administrative expenses divided by sales);
3. R&D intensity (total R&D expenditures divided by sales—total R&D expenditures refer to total R&D investments, which include both capitalized and expensed R&D amounts);
4. market-to-book ratio (the market value of equity divided by the book value of equity).

We used the selling, general, and administrative (SG&A) expenses ratio to capture the firms’ investment needed to promote a differentiation strategy [22,46,47]. Banker et al. [22] used the number of employees to assets ratio to capture input to output. This study applies that logic similarly, but uses the total cost ratio instead. We include R&D intensity, a key factor of differentiation strategy [47–49]. We also include the market-to-book ratio, as a good reputation translates into better performance [50,51]. All four variables are the average from t-1 to t-3.

We conducted a principal component factor (PCF) analysis with the above four variables to get the common factors that can represent firms’ strategic positioning. To test the adequacy of the sample for factor analysis, the Kaiser–Meyer–Olkin (KMO) test and Bartlett’s test of sphericity were used. The KMO statistic is 0.582 (greater than 0.50) and the approximate of the chi-square is 20,316.945, with 6 degrees of freedom, which is significant at the 1% level. The test results for KMO and Bartlett indicate that the sample is adequate.

\(X_{i,t}\) is the other factor affecting firms’ performance. We first included size, which is measured as the natural log of total assets, for size effects control. We also controlled leverage, which is the
total liabilities divided by total assets. Sales growth, changes in sales = (sales_t − sales_{t-1})/sales_{t-1}, and operating cash flows, which are divided by assets, were also included. IND is the industry sector dummy variable, defined by the one-digit Korea Standard Industry Code, and YEAR is the year dummy variable.

To examine Hypothesis 2, the following OLS regression model was used.

\[
PERSROA_{i,t+1} = \alpha + \beta_1 DIFFROA_{i,t} + \beta_2 DIFFRDdec_{i,t} + \sum \alpha_j X_{j,t} + \sum \alpha_k IND_k + \sum \alpha_l YEAR_l + \epsilon_{i,t}
\]  

(3)

where PERSROA_{i,t+1} is persistence of return on asset (ROA) and DIFFROA is the interaction between DIFF and ROA, and DIFFRDdec is the interaction between DIFFROA and RDdec. RDdec is a dummy variable which is coded as 1 if R&D intensity (total R&D expenditures divided by sales) is decreased in year t. Otherwise, it is coded as 0. X_{j,t} representing the other factor affecting a firm’s performance such as size, leverage, sales growth and operating cash flow. The industry sector dummy variable and the year dummy variable were also included to control time and industry specific effects.

To examine Hypotheses 3-1 and 3-2, the following OLS regression model was used.

\[
PERSROA_{i,t+1} = \alpha + \beta_1 DIFFROA_{i,t} + \beta_2 DIFFRDdec_{i,t} + \beta_3 DIFFRDdecBIO_{i,t} + \beta_4 DIFFRDdecBIOPS_{i,t} + \sum \alpha_j X_{j,t} + \sum \alpha_k IND_k + \sum \alpha_l YEAR_l + \epsilon_{i,t}
\]

(4)

where PERSROA_{i,t+1} is persistence of ROA, DIFFROA is the interaction between DIFF and ROA, and DIFFRDdec is the interaction between DIFFROA and RDdec. RDdec is a dummy variable coded as 1 if R&D intensity (total R&D expenditures divided by sales) is decreased in year t. Otherwise, it is coded as 0. DIFFRDdecBIO is the interaction between DIFFRDdec and BIO, the biotech dummy variable. Biotech refers to both biopharma firms and biotech firms. DIFFRDdecBIOPS is the interaction between DIFFRDdecBIO and PS, where PS is coded as 1 if the change in sales is positive, and 0 otherwise. X_{j,t} is the other factor affecting a firm’s performance, such as size, leverage, sales growth, and operating cash flow. The industry sector dummy variable and the year dummy variable were also included to control time and industry specific effects.

4. Empirical Results

4.1. Descriptive Statistics

Table 2 shows the descriptive statistics for the variables. The mean (median) value for the dependent variable, PERSROA is 0.0256 (0.0312). The mean (median) values for the interaction between ROA and the differentiation strategy is −0.0177 (−0.0043). DIFFRDdec, DIFFRDdecBIO, and DIFFRDdecBIOPS are −0.0080 (0), −0.0014 (0), and −0.0005 (0), respectively. The mean (median) values for control variables SIZE, LEV, GROW, and OCF are 18.5675 (18.3605), 0.4220 (0.4198), 0.9490 (0.8554), and 0.0544 (0.0514), respectively.
| Variables      | Mean   | StdDev  | Median  | Q1     | Q3     |
|----------------|--------|---------|---------|--------|--------|
| PERSROA       | 0.0256 | 0.0576  | 0.0312  | 0.0152 | 0.0524 |
| DIFFROA       | −0.0177| 0.2182  | −0.0043 | −0.0155| 0.0020 |
| DIFFRDdec     | −0.0080| 0.1273  | 0       | −0.0030| 0      |
| DIFFRDdecBIO  | −0.0014| 0.0613  | 0       | 0      | 0      |
| DIFFRDdecBIOPS| −0.0005| 0.0243  | 0       | 0      | 0      |
| SIZE          | 18.5675| 1.4969  | 18.3605 | 17.5686| 19.3327|
| LEV           | 0.4220 | 0.2091  | 0.4198  | 0.2561 | 0.5727 |
| GROW          | 0.9490 | 0.5630  | 0.8554  | 0.5717 | 1.2064 |
| OCF           | 0.0544 | 0.1017  | 0.0514  | 0.0001 | 0.1089 |

Notes: PERSROA: persistence of return on asset. DIFFROA: the interaction between differentiation strategy and ROA. DIFFRDdec: the interaction between differentiation strategy and the RDdec dummy variable, where RDdec is a dummy variable coded as 1 if R&D intensity is decreased in year t. DIFFRDdecBIO: the interaction between DIFFRDdec and the biotech dummy variable. DIFFRDdecBIOPS: the interaction between DIFFRDdecBIO and PS, coded as 1 if the change in sales is positive, and 0 otherwise. SIZE: natural logarithm of total assets. LEV: total liabilities divided by total assets. GROW: sales growth, the changes in sales = (sales_t − sales_{t-1})/sales_{t-1}. OCF: operating cash flow divided by total assets.

The Pearson correlation results are reported in Table 3. Significant positive correlations are observed between persistence of return on asset (PERSROA) and all of the explanatory variables (DIFFROA, DIFFRDdec, DIFFRDdecBIO, and DIFFRDdecBIOPS) \((p < 0.01)\). Significant positive correlations are also seen between PERSROA and some of the control variables (SIZE, GROW, OCF) \((p < 0.01)\). Significant negative correlations are observed between persistence of return on asset and the control variable, LEV \((p < 0.01)\). To test for multi-collinearity, the variance inflation factors (VIFs) were computed, including VIFs for all variables <10, mean VIF 1.18. Thus, we conclude that no multi-collinearity problems are evident.
Table 3. Pearson correlations.

| Variable     | PERSROA | DIFFROA | DIFFRDdec | DIFFRDdecBIO | DIFFRDdecBIOPS | SIZE | LEV | GROW | OCF |
|--------------|---------|---------|-----------|--------------|----------------|------|-----|------|-----|
| PERSROA     | 1.0000  |         |           |              |                |      |     |      |     |
| DIFFROA     |         | 1.0000  |           |              |                |      |     |      |     |
| DIFFRDdec   | 0.2154  | 0.5806  | 1.0000    |              |                |      |     |      |     |
| DIFFRDdecBIO| 0.0660  | 0.2790  | 0.4799    | 1.0000       |                |      |     |      |     |
| DIFFRDdecBIOPS| 0.0495 | 0.1096  | 0.1894    | 0.3958       | 1.0000         |      |     |      |     |
| SIZE        | 0.0687  | 0.0662  | 0.0475    | 0.0212       | 0.0123         | 1.0000|     |      |     |
| LEV         | −0.2533 | −0.0033 | 0.0105    | 0.0002       | −0.0040        | 0.1051| 1.0000| 0.9647| 0.1403|
| GROW        | 0.2230  | 0.0634  | 0.0560    | 0.0368       | 0.0234         | −0.0915| 0.2544| 0.0000| 1.0000 |
| OCF         | 0.5107  | 0.1051  | 0.0982    | 0.0534       | 0.0348         | 0.0332 | −0.1242| 0.2093| 1.0000 |

Note: See Table 2 for variable definitions.
4.2. Regression Results and Discussion

Table 4 represents the OLS regression results for Hypothesis 1, the association between the differentiation strategy and future performance sustainability. As demonstrated in prior literature, the results show that there is a significant positive association between future performance sustainability and the differentiation strategy ($p < 0.01$). The results prove that future sustainability of accounting earnings has a significant impact on implementing a management strategy, and provides support for Hypothesis 1.

**Table 4. Regression results.**

| Variables | Expected Sign | Dependent Variable: PERSROA |
|-----------|---------------|-------------------------------|
|           | OLS Regression | Fixed Effect (year)           |
| Constant  | ?             | $-0.0828\ *** (-13.08)$       |
|           |                | $-0.2036\ *** (-14.66)$       |
| DIFFROA   | $+$           | $0.0419\ *** (28.08)$        |
|           |                | $0.0323\ *** (21.68)$        |
| SIZE      | $+$           | $0.0068\ *** (28.36)$        |
|           |                | $0.0141\ *** (18.65)$        |
| LEV       | $-$           | $-0.0856\ *** (-49.37)$      |
|           |                | $-0.1122\ *** (-43.58)$      |
| GROW      | $+$           | $0.0189\ *** (28.76)$        |
|           |                | $0.0289\ *** (26.93)$        |
| OCF       | $+$           | $0.2146\ *** (58.25)$        |
|           |                | $0.1593\ *** (40.06)$        |
| Industry dummies | Included | Included |
| Year dummies | Included | Included |
| $F$ value |                | $341.43\ ***$                |
| Adjusted $R^2$ |           | $0.3626$               |
| $N$       |                | 19,749                        |

Note: See Table 2 for variable definitions. t-values are shown in parentheses. *** $p < 0.01$.

Significant associations are also seen between DIFFROA and the control variables. Some of the control variables (SIZE, GROW, OCF) show a significant positive association with DIFFROA, and LEV shows a significant negative association. The results for the fixed-effect regression remained consistent with the OLS results for the explanatory variables. A measurement of variables through the fixed-effect regression analysis provided a more-accurate inference of model parameters. Additionally, a panel data gathered data to generate more-accurate predictions about individual outcomes and confident results [52].

Through the results shown in Table 5, we can see how a reduction of R&D intensity affected the association between differentiation strategy and future performance sustainability. According to the OLS regression analysis, future performance sustainability has a significant positive association with differentiation strategy, even when R&D intensity decreases ($p < 0.01$). These results provide support for Hypothesis 2. The results can be interpreted that while growing firms may decrease R&D in an attempt to pursue more-aggressive differentiation strategies, such reduction of R&D intensity does not have a negative impact on the persistence of accounting income. The results confirm that a decrease of R&D investments with the aim of carrying out the appropriate strategy does not hurt the positive impact of differentiation strategy on the sustainability of accounting outcomes.
Significant associations are also seen between DIFFROA and the control variables. Some of the control variables (SIZE, GROW, OCF) showed a significant positive association with DIFFROA, and LEV showed a significant negative association. The results for the fixed-effect regression remained consistent with the OLS results for the explanatory variables.

Table 6 represents the OLS regression results for Hypotheses 3-1 and 3-2. For biotech firms with reduced R&D intensity, the association between future performance sustainability and differentiation strategy is significantly negative (p < 0.01). This result provides support for Hypothesis 3a, and thus confirms that the R&D investment decrease of biotech firms is more likely to have a negative impact on the association between differentiation strategy and future performance sustainability than that of firms in other industries. This implies that the importance of continuous R&D investment is a key differentiation strategy for a biotech firm’s sustainability.

Table 6. Regression results.

| Variables       | Expected Sign | Dependent Variable: PERSROA | OLS Regression | Fixed Effect (year) |
|-----------------|---------------|------------------------------|----------------|---------------------|
| Constant        | ?             | −0.0819 *** (−13.04)         | −0.1995 *** (−14.47) |
| DIFFROA         | +             | 0.0263 *** (14.54)           | 0.0164 *** (9.15)  |
| DIFFRDdec       | +             | 0.0582 *** (17.22)           | 0.0548 *** (16.57) |
| DIFFRDdecBIO    | −             | −0.0564 *** (−8.75)          | −0.0430 *** (−6.33) |
| SIZE            | +             | 0.0400 *** (2.78)            | 0.0305 ** (2.22)   |
| LEV             | −             | −0.0860 *** (−49.97)         | −0.1121 *** (−43.87) |
| GROW            | +             | 0.0188 *** (28.85)           | 0.0289 *** (27.13) |
| OCF             | +             | 0.2123 *** (57.93)           | 0.1575 *** (40.18) |
| Industry dummies|               | Included                     | Included         |
| Year dummies    |               | Included                     | Included         |
| F value         |               | 326.31 ***                   | 259.41 ***       |
| Adjusted R²     |               | 0.3723                       | 0.3362           |
| N               |               | 19,749                       | 19,749           |

Note. See Table 2 for variable definitions. t-values are shown in parentheses. ** p < 0.05, *** p < 0.01.

As described in the hypothesis development section, the R&D intensity decrease may have been due to a decrease in firms’ R&D investments, or firms’ sales increases, as R&D intensity is calculated by dividing total R&D expenditures by sales. Given the increase in sales, regardless of whether the amount of R&D investment remains unchanged or decreases, we further investigated...
the case of biotech firms whose change in sales was positive. The result for this case showed that future performance sustainability is significantly positively associated with a differentiation strategy ($p < 0.05$). The results provide support for Hypothesis 3b and can be interpreted in two ways: First, the amount of firms’ R&D investments have not changed much, but the firms’ sales are increasing, which means that the companies are growing as the R&D investment has succeeded. Second, even if the firms’ R&D investments decline, the firms’ sales increases are more than that decline, which can be interpreted that the companies are likely to be in their mature stage. In conclusion, particularly for biotech companies aiming at sustainable technology development through R&D investment, a differentiation strategy through R&D investment seems to have more significant impact on future performance sustainability than other industries. As a reduction in R&D intensity will have a negative impact on the persistence of accounting income for biotech firms, policymakers need to recognize the special propensity of biotech companies and create an environment that can foster their future sustainable growth potential. For examples, key evaluation indicators for biotech companies should emphasize future sustainable growth, such as the possibility of sales expansion and expected profits after developing new drugs rather than immediate product competitiveness.

Significant associations are also seen between DIFFROA and the control variables. Some of the control variables (SIZE, GROW, OCF) show a significant positive association with DIFFROA, and LEV shows a significant negative association. The results for the fixed-effect regression remained consistent with the OLS results for the explanatory variables.

### 4.3. Robustness Regression

An analysis is carried out on the regression models using robust regression techniques to eliminate the influence of outlier biases in all specifications. As can be seen in Table 7, the results of the study remained consistent when run through a robustness check.

| Variables          | Expected Sign | Dependent Variable: PERSROA | Clustered Robust (year) |
|--------------------|---------------|------------------------------|-------------------------|
| Constant           | ?             | −0.0828 *** (−5.40)         | −0.0825 *** (−5.56)     | −0.0819 *** (−5.62)  |
| DIFFROA            | +             | 0.0419 *** (6.43)           | 0.0263 *** (5.49)       | 0.0263 *** (5.48)   |
| DIFFRDdec          | +             | 0.0469 *** (3.01)           | 0.0582 ** (2.53)        |                       |
| DIFFRDdecBIO       | −             | −                            | −0.0564 * (−1.94)       |                       |
| DIFFRDdecBIOPS     | +             | −                            | 0.0400 * (2.17)         |                       |
| SIZE               | +             | 0.0068 *** (8.89)           | 0.0068 *** (9.17)       | 0.0067 *** (9.26)   |
| LEV                | −             | −0.0856 *** (−22.79)        | −0.0859 *** (−22.81)    | −0.0860 *** (−22.85) |
| GROW               | +             | 0.0189 *** (15.11)          | 0.0188 *** (15.09)      | 0.0188 *** (14.75)  |
| OCF                | +             | 0.2146 *** (28.86)          | 0.2123 *** (28.09)      | 0.2123 *** (28.04)  |
| Industry dummies   | Included       | Included                     | Included                 | Included             |
| Year dummies       | Included       | Included                     | Included                 | Included             |

| Chi-Square         | 0.3637         | 0.3710                       | 0.3734                   |
| N                  | 19,749         | 19,749                       | 19,749                   |

Note: See Table 2 for variable definitions. t-values are shown in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

### 5. Conclusions

As uncertainty in management environments is mounting and competition intensifying, R&D activities are continually more vital. This is because growing competitiveness through differentiation strategies has appeared as the key factor for survival and growth in an environment where consumer tastes are constantly evolving and competition exists between global companies. Firms are encountering a competitive environment where they not only need to develop products that can be chosen by consumers, but also can create innovative products that will generate demand for sustainable growth. To respond to this change of environment, firms are investing in facility development for
quantitative growth, while strengthening R&D investment to improve qualitative competitiveness. Management strategies are consequently evolving as the management environment evolves.

The importance of R&D investment will only deepen in the knowledge economy era. However, firms tend to hesitate in actively making decisions for investment because R&D investment does not bring immediate results and has a high degree of uncertainty. In these situations, the method to assure success for firms is to construct strategy goals considering the firm’s distinctive characteristics and eventually to advance the firm’s profitability and overall value. Therefore, this paper investigates how the management strategies mentioned by Porter [1,2] influence the persistence of accounting earnings of firms in the Korean capital market by separating biotech firms, which are leaders in the knowledge economy era, and non-biotech firms. Moreover, in cases where R&D investment is reduced due to a change of the management environment, this study also verifies whether this alters the effect of the management strategy on future sustainable outcomes.

The summary of the results is as follows: First, when implementing a management strategy in consideration of internal and external environments, significant effects on the future sustainability of accounting earnings appeared. Second, appropriately applying a differentiation strategy significantly influenced the sustainability of accounting performance, even when reducing R&D investments. Third, the influence on future sustainability of accounting earnings was observed to be affected by R&D intensity for biotech firms when they implement the key differentiation strategy.

The Korean stock market experienced a peculiar phenomenon in 2018 where prices of biotech stocks increased sharply in the short term. However, according to the Korea Biotechnology Industry Organization, 30.3% (281) out of 926 biotech firms reported having no sales or zero sales, and 37.3% (343) could not reach the break-even point. Biotech firms are expected to achieve high profitability, yet their stock prices are overvalued while their fundamentals are fairly low. Thus, policymakers and investors need to take caution regarding the diverse tendencies of biotech firms mentioned in this study. Specifically, policymakers must capture how to assess the future sustainable potential of biotech firms. In this regard, wise judgement of current and potential shareholders is especially necessary.

This study has the following caveats: First, because of the relatively minor number of biotech firms, the small sample size may limit this study in sophistication. Second, this study used the persistence of accounting earnings by focusing on the sustainability concept in measuring an economic entity’s performance. However, it is important to properly measure the corporate performance in recent business environments. According to literature [53], the concept of physical capital maintenance is superior to the concept of financial capital maintenance to proxy for a firm’s real performance. Although it is accepted that sustainable performance by physical capital maintenance reflects the real profit of a firm, measuring physical capital is more difficult than evaluating financial capital. Thus, we will consider it as a limitation of this study. Nevertheless, this paper contributes to the literature through a demonstration of how varying the scale of R&D investment influences the relationship between management strategy and the persistence of accounting earnings by comparing of biotech and non-biotech firms.

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