International Journal of Economics and Financial Issues

ISSN: 2146-4138

available at http: www.econjournals.com

International Journal of Economics and Financial Issues, 2025, 15(6), 151-163.

R&D Investment and Tax Avoidance Strategies under K-IFRS: Nonlinear Evidence from the Korean Stock Market

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Received: 06 May 2025 **Accepted:** 11 September 2025 **DOI:** https://doi.org/10.32479/ijefi.20733

ABSTRACT

This study investigates the impact of R&D investments on tax avoidance among companies listed on the Korean stock market from 2011 to 2023. It classifies R&D investments into two categories: R&D expenses, recorded as ordinary business expenses, and development costs (capitalized R&D expenses), recognized as assets. The research examines whether these two forms of R&D investment have distinct effects on tax avoidance and explores whether these relationships follow linear or nonlinear patterns. Using an empirical model, the study employs tax avoidance measures (BTD and DDBTD) as dependent variables, with R&D expenses and development costs as key independent variables. The findings reveal that R&D expenses are positively associated with tax avoidance, whereas development costs exhibit a negative relationship. Furthermore, the relationship between R&D expenses and tax avoidance is nonlinear, following an inverted U-shape: Tax avoidance increases with R&D expenses up to a certain threshold but decreases beyond that point. In contrast, development costs consistently show a linear negative relationship with tax avoidance. This study suggests that in the Korean stock market, companies primarily engage in tax avoidance through R&D expenses. However, excessive R&D expenses can lead to a decrease in tax avoidance. By exploring the connection between R&D investment and tax avoidance, this study provides new insights into how companies use R&D strategies for tax planning.

Keywords: R&D, Tax Avoidance, R&D Investment, Development Costs, Nonlinear Relationship, Korean Stock Market, K-IFRS
JEL Classifications: M41, G31, G32

1. INTRODUCTION

Corporations use various strategies to maximize shareholder wealth, and tax avoidance is one of the most significant methods. By reducing tax liabilities, companies can retain more cash, which enhances their financial flexibility and investment potential. In tax research, any action aimed at lowering tax payments is considered tax avoidance, whether it is legal (Miller and Oats, 2014) or illegal (Dyreng et al., 2008; Hanlon and Heitzman, 2010; Keum and Kweon, 2013; Choi and Kweon, 2016; Kim et al., 2017; Lee and Kim, 2019; Park and Kim, 2020; Wu and Kwon, 2023). Among the different tax avoidance strategies, investing in research and development (R&D) is particularly important because R&D expenditures are crucial for driving a company's future growth.

Under Korea's corporate accounting standards (K-IFRS), corporate management can decide whether to classify R&D investments as expenses or capitalize them as development costs (Korean Accounting Institute, 2021). This flexibility is also reflected in Korea's Corporate Tax Act. R&D costs classified as expenses under accounting standards are deductible under tax law, reducing taxable income. On the other hand, development costs that are capitalized as intangible assets are amortized over a period of up to 20 years using different methods such as straight-line depreciation. Since both expensed and capitalized R&D investments receive tax benefits, companies may strategically choose their accounting method to optimize financial reporting and tax savings (Koh and Lee, 2011; Ma and Yoo, 2020; Choi and Cho, 2022).

Under K-IFRS and the Corporate Tax Act, expensed R&D costs yield immediate tax benefits, whereas capitalized development costs offer benefits over time through amortization. This timing difference may influence firms' decisions on classifying R&D investments, affecting their tax avoidance strategies depending on whether costs are expensed immediately or capitalized.

This study measures R&D investment by combining development costs and R&D expenses, classifying them as ordinary R&D expenditures (Choi, 1994). The study examines how the strategic distinction between expensing and capitalizing R&D investments influences corporate tax avoidance behavior, offering insights into tax planning strategies.

This study examines how corporate R&D investments impact tax avoidance in the Korean stock market from 2011 to 2023. It explores whether R&D costs, when expensed immediately or capitalized, affect tax avoidance. The results show that R&D expenses increase tax avoidance, while development costs have no significant impact. Additionally, a nonlinear relationship is observed, where tax avoidance remains stable or decreases at lower levels of R&D spending but rises sharply once expenditures exceed a certain threshold. This suggests that excessive R&D spending accelerates tax avoidance.

The study is structured as follows. Chapter II presents the theoretical background, covering K-IFRS, tax regulations on R&D investments, and prior research on R&D and tax avoidance. Chapter III outlines the research hypotheses and models used in the analysis. Chapter IV details the data collection process and empirical results. Finally, Chapter V summarizes the findings, discusses their implications, and acknowledges the study's limitations.

2. THEORETICAL BACKGROUND

Chapter 2 examines K-IFRS standards for R&D expense treatment, related Corporate Tax Act regulations, available tax incentives, and literature on R&D expenditures' role in tax avoidance strategies.

2.1. Regulations on the Treatment of R&D Expenses under the K-IFRS and the Korean Corporate Tax Act

2.1.1. R&D cost treatment regulations of the K-IFRS

The evolution of Korean accounting standards has undergone significant changes over the years, particularly in the treatment of R&D expenses. Initially outlined in the "Accounting Principles for Business" (1958-1980), the regulations for R&D expenses were categorized as deferred assets or current testing and research expenses. In 1987, the "Accounting Principles for Research and Development" was enacted, followed by the "Corporate Accounting Standards No. 3 Intangible Assets" (2000), and finally, the "Korean International Financial Reporting Standards (K-IFRS) No. 1038 Intangible Assets" (2011-Present) (Korean Accounting Institute, 2019). Under the K-IFRS framework, R&D expenses are divided into two stages: the research and development phases.

In the research phase, expenditures are treated as current period expenses due to the absence of identifiable intangible assets capable of generating future economic benefits. Conversely, during the development phase, costs can be capitalized as intangible assets, as they are associated with the creation of potential future benefits. However, if distinguishing between the research and development stages is not feasible, all costs are treated as research expenses (Korean Accounting Institute, 2021).

This framework reflects Korea's alignment with international standards, offering a more structured and precise approach to R&D accounting. The comparison of activities occurring in the research phase and activities occurring in the development phase presented in K-IFRS No. 1038, "Intangible Assets," is as shown in Table 1.

However, since this distinction depends on the choice of managers or accountants under the direction of managers, it is difficult to expect that all companies will process it according to the same standards.

2.1.2. Regulations on the treatment of R&D expenses under the Korean corporate tax act

The Corporate Tax Act's regulations on R&D expenses align closely with the treatment under the K-IFRS No. 1038, with differences mainly in terminology. Article 24 of the Enforcement Decree defines development expenses as costs incurred in applying research results to create or improve materials, equipment, or products prior to commercialization. Furthermore, Article 43 of the Corporate Tax Act mandates that domestic corporations adhere to generally recognized corporate accounting standards unless specified otherwise by the Act or other tax regulations.

Development expenses under the Corporate Tax Act can be amortized over a period of up to 20 years using methods such as the straight-line method or the production volume proportional method, allowing for them to be treated as deductible expenses. In contrast, research expenses that do not meet the criteria for intangible asset development must be recorded as current period expenses. This demonstrates that the tax treatment of R&D expenses under the Corporate Tax Act is in direct alignment with

Table 1: Examples of research and development activities in K-IFRS

Examples of research activities	Examples of development activities
1. Activities to acquire new knowledge 2. Activities to explore, evaluate, make a final selection, and apply research results or other knowledge 3. Activities to explore various alternatives for materials, devices, products, processes, systems, or services 4. Activities involve proposing, designing, evaluating, and making a final selection among various alternatives for new or improved materials, devices, products, processes, systems, or services.	1. Activities to design, manufacture, and test prototypes and models before production or use 2. Activities include designing tools, jigs, molds, and dies related to new technologies. 3. Activities to design, construct, and operate a pilot plant that is not economically feasible for commercial production purposes 4. Activities involve designing, manufacturing, and testing the final selection for new or improved materials, devices, products, processes, systems, or services.

Source: Summary from K-IFRS No. 1038 "Intangible Assets"

K-IFRS, ensuring consistent handling of these costs for both financial accounting and taxation purposes.

2.2. Tax support system related to Research and Development in Korea

National-level support for R&D is crucial for enhancing a country's industrial competitiveness by fostering new technologies, boosting technological capabilities, and improving long-term productivity, which contributes to economic growth. In Korea, the tax support system for R&D encompasses direct and indirect methods, including tax deductions, reductions, income deductions, and reserve fund deductions.

Korea's R&D tax support began in 1966 with a tax reduction for technology introduction costs and expanded over the years. The 1970s saw the introduction of tax incentives for R&D and human resource development reserves, followed by tax deductions for R&D facility investments and local tax exemptions for corporate research institutes in the 1980s. By the 1990s, income deductions for technical personnel were also included. Although some systems have been phased out, tax support remains for various R&D-related activities.

As of 2023, the R&D tax support system includes multiple measures, such as the Research and Human Resources Development Expenses Tax Credit, Integrated Investment Tax Credit for research facilities, and special tax cases for technology transfer, foreign technicians, and corporate research institutes. These systems play a key role in promoting technological innovation and advancing Korea's R&D sector.

2.3. Previous Studies on the Relationship between R&D Investment and Tax Avoidance

The relationship between R&D expenditures and tax avoidance strategies has been widely examined in the context of corporate tax planning, with several studies focusing on how tax incentives and accounting treatments influence corporate behavior. This section reviews key findings from past research on the role of tax support systems, R&D investment, and tax avoidance in Korea.

Cho and Seong (2003) examine the impact of tax support systems on corporate R&D spending in Korea post-IMF crisis. They find that technology development reserves and tax credits for tech and human resource development positively influence R&D investments, highlighting the importance of tax incentives in promoting corporate R&D.

In contrast, Ko (2004) evaluates the impact of R&D and temporary investment tax credits, finding no significant effect on capital expenditures or R&D investment. The study suggests that R&D tax credits alone may not effectively incentivize R&D without complementary tax mechanisms, highlighting the lack of interdependence between the two systems.

Kim and Son (2006) explore the impact of tax support benefits on R&D activities using survey data from the Korea Industrial Technology Promotion Association. Their study reveals that tax credits, company size, and asset levels significantly influence R&D investment. Larger firms, in particular, are more likely to benefit from tax credits, which in turn affect the scale of their R&D expenditures.

Koh and Lee (2011) examine how the choice of R&D cost accounting affects tax avoidance, finding that low-technology firms are more likely to leverage the accounting treatment of development costs for tax avoidance than high-technology firms. This is because the treatment of development costs under corporate accounting standards and tax law is similar, offering firms an opportunity to strategically minimize tax liabilities.

Oh et al. (2011) compare R&D expenditures between SMEs that pay the minimum tax rate and those that do not. Their findings show that SMEs subject to the minimum tax rate tend to increase their R&D expenditures more than those not subject to it. Furthermore, when the minimum tax rate is lowered, R&D expenditures decrease, suggesting that the minimum tax system has a unique influence on the R&D investment behavior of SMEs.

Lee (2014) examines the relationship between corporate donations and tax avoidance, reporting a significant negative relationship between the two. This indicates that firms with higher donation expenditures tend to engage in less tax avoidance, potentially due to a stronger commitment to corporate social responsibility.

Park et al. (2014) focus on the relationship between corporate donations and tax evasion among firms listed on the KOSDAQ market. Their study shows that firms with higher donation expenditures relative to sales tend to exhibit lower levels of tax evasion, suggesting that corporate donations are linked to more ethical tax behavior.

Kim et al. (2019) study the impact of discretionary R&D expenditures on tax avoidance, finding that discretionary spending contributes to tax avoidance but exhibits an inverted U-shaped relationship. They suggest that companies use discretionary R&D expenses strategically within the limits of tax incentives, but excessive spending beyond a certain threshold can reduce the effectiveness of tax avoidance strategies.

Ma and Yoo (2020) examine the effects of accounting treatment of R&D expenses on tax avoidance in Korean listed companies. Their findings suggest that expensed R&D costs, total R&D expenditures, and current development costs increase tax avoidance in the current period, highlighting that firms can use discretionary R&D accounting choices as part of their tax strategy.

Finally, Choi and Cho (2022) investigate whether firms capitalize R&D expenses to reduce tax risks. Their study finds that companies facing higher tax risks are more likely to capitalize R&D expenditures as a strategy to reduce future tax liabilities. The research also indicates that high R&D spending in the current period may lead to stronger tax authority supervision, making it harder for firms to capitalize a larger share of their R&D expenses.

Overall, these studies emphasize the strategic role of R&D expenditures, tax incentives, and accounting treatments in corporate tax avoidance. Firms use various tools, including tax credits, discretionary accounting choices, and capitalization strategies, to optimize their tax liabilities while fostering R&D investment. These findings contribute to a deeper understanding of the complex relationship between R&D investment and tax strategies in corporate settings.

3. HYPOTHESIS AND RESEARCH MODEL

3.1. Hypothesis

The Korean corporate tax law encourages firms to invest resources in R&D activities through a variety of tax incentive schemes. Firms can expect to increase their future value by exploiting improved technological capabilities through R&D investment. At the same time, they have incentives to reduce taxes through discretionary choices in the accounting and tax treatment of R&D investment (Koh et al., 2007; Ma and Yoo, 2020; Choi and Cho, 2022).

If a company treats the R&D investment as an R&D expense in the current period, the tax saving is realized in the current period, but if it treats it as a development cost, the tax saving is realized later in the next period. The choice of how to treat R&D investments is almost entirely left to the company. Therefore, it is necessary to examine the relationship between R&D expenditure, development costs and tax avoidance to explore how a company accounts for R&D expenditure to avoid tax.

Since it is expected that Korean firms will engage in tax avoidance through R&D investment, this study aims to examine whether there is a relationship between R&D investment and tax avoidance. In particular, it is expected that the effects of R&D expenditure and development cost on tax avoidance will be different due to the option of expensing and amortization of R&D investment allowed by Korean International Financial Reporting Standards (K-IFRS) and the Corporate Tax Act. Therefore, the research hypotheses of this study are as follows.

Hypothesis 1: R&D expenses are significantly related to tax avoidance

Hypothesis 2: Development costs are significantly related to tax avoidance.

The tax incentive system can motivate companies to invest resources more actively in R&D activities. However, tax incentives are not provided to companies indefinitely and are limited in time. Therefore, while tax incentives may motivate R&D expenditure up to a certain level, if it is excessive, the motivation is likely to be tax avoidance for additional tax savings rather than tax incentives. Therefore, R&D expenditure below a certain level is unrelated or negatively related to tax avoidance, but expenditure above a certain level is likely to significantly increase tax avoidance because the purpose of tax avoidance is large. In order to verify this, it is necessary to examine the structure of the relationship between R&D expenditure and tax avoidance, and to this end this study formulates and tests the following hypotheses.

Hypothesis 3: R&D expenses are nonlinearly related to tax avoidance.

Hypothesis 4: Development costs are nonlinearly related to tax avoidance.

3.2. Research Model

The purpose of this paper is to test the effects on tax avoidance of R&D investment treated as expenses and development costs treated as assets. To this end, this study designs a research model in which tax avoidance (DDBTD, BTD) is the dependent variable and R&D expenses and development costs are set as the main independent variables.

In particular, this study additionally investigates whether the structure of the effects of R&D expenses treated as expenses and development cost costs treated as assets on corporate tax avoidance is linear or nonlinear. The main dependent variables of this study are the difference between accounting income and tax income (BTD) and the residual (DDBTD) of the regression of total accruals on the difference between accounting income and tax income (BTD), respectively, as proxy variables for tax avoidance (Park, 2004; Desai and Dharmapala 2006; Kim et al. 2019).

Control variables include donations to represent corporate social responsibility activities, growth ratio and sales growth rate to reflect firm growth potential, debt ratio to indicate financial status, return on assets to reflect profitability, firm size, intangible asset ratio, capital intensity and firm age. Industry and year dummies were also included in the research model to control for industry and year effects.

The <Research Model 1> and <Research Model 2> are designed to test the effect of R&D costs treated as expenses on tax avoidance (DDBTD, BTD) using linear equations, and the <Research Model 3> and <Research Model 4> are used to test the effect of development costs treated as assets on tax avoidance (DDBTD, BTD). <Research Model 5> and <Research Model 7> are designed to test the form of the effect of R&D costs treated as expenses on tax avoidance (DDBTD, BTD) using quadratic equations, and <Research Model 6> and <Research Model 8> are intended to test the form of the effect of development costs treated as assets on tax avoidance (DDBTD, BTD) (Morck et al., 1988; Beneish and Harvey 1998; Gul et al., 2010).

$$DDBTD_{i,t} = \beta 0 + \beta 1EXPRND_{i,t} + \beta 2DON_{i,t} + \beta 3TOP_{i,t} + \beta 4MTB_{i,t} + \beta 5SIZE_{i,t} + \beta 6LEV_{i,t} + \beta 7ROA_{i,t} + \beta 8GRW_{i,t} + \beta 9INT_{i,t} + \beta 10PPE_{i,t} + \beta 11AGE_{i,t} + \beta 12\sum ID + \beta 13\sum YD + \varepsilon_{i,t}$$
<Research Model 1>

$$DDBTD_{i,t} = \beta 0 + \beta 1CAPRND_{i,t} + \beta 2DON_{i,t} + \beta 3TOP_{i,t} + \beta 4MTB_{i,t} + \beta 5SIZE_{i,t} + \beta 6LEV_{i,t} + \beta 7ROA_{i,t} + \beta 8GRW_{i,t} + \beta 9INT_{i,t} + \beta 10PPE_{i,t} + \beta 11AGE_{i,t} + \beta 12\sum ID + \beta 13\sum YD + \varepsilon_{i,t}$$
<Research Model 2>

$$BTD_{i,t} = \beta 0 + \beta 1EXPRND_{i,t} + \beta 2DON_{i,t} + \beta 3TOP_{i,t} + \beta 4MTB_{i,t} + \beta 5SIZE_{i,t} + \beta 6LEV_{i,t} + \beta 7ROA_{i,t} + \beta 8GRW_{i,t} + \beta 9INT_{i,t} + \beta 10PPE_{i,t} + \beta 11AGE_{i,t} + \beta 12\sum ID + \beta 13\sum YD + \varepsilon_{i,t}$$
<Research Model 3>

$$BTD_{i,t} = \beta 0 + \beta 1CAPRND_{i,t} + \beta 2DON_{i,t} + \beta 3TOP_{i,t} + \beta 4MTB_{i,t} + \beta 5SIZE_{i,t} + \beta 6LEV_{i,t} + \beta 7ROA_{i,t} + \beta 8GRW_{i,t} + \beta 9INT_{i,t} + \beta 10PPE_{i,t} + \beta 11AGE_{i,t} + \beta 12\sum ID + \beta 13\sum YD + \varepsilon_{i,t}$$
<Research Model 4>

$DDBTD_{i,t} = \beta 0 + \beta 1EXPRND_{i,t} + \beta 2EXPRND2_{i,t} + \beta 3DON_{i,t} + \beta 4TOP_{i,t} + \beta 5MTB_{i,t} + \beta 6SIZE_{i,t} + \beta 7LEV_{i,t} + \beta 8ROA_{i,t} + \beta 9GRW_{i,t} + \beta 10INT_{i,t} + \beta 11PPE_{i,t} + \beta 12AGE_{i,t} + \beta 13\sum ID + \beta 14\sum YD + \varepsilon_{i,t}$

<Research Model 5>

$DDBTD_{i,t} = \beta 0 + \beta 1CAPRND_{i,t} + \beta 2CAPRND2_{i,t} + \beta 3DON_{i,t} + \beta 4TOP_{i,t} + \beta 5MTB_{i,t} + \beta 6SIZE_{i,t} + \beta 7LEV_{i,t} + \beta 8ROA_{i,t} + \beta 9GRW_{i,t} + \beta 10INT_{i,t} + \beta 11PPE_{i,t} + \beta 12AGE_{i,t} + \beta 13\sum ID + \beta 14\sum YD + \varepsilon_{i,t}$

<Research Model 6>

$BTD_{i,t} = \beta 0 + \beta 1EXPRND_{i,t} + \beta 2EXPRND2_{i,t} + \beta 3DON_{i,t} + \beta 4TOP_{i,t} + \beta 5MTB_{i,t} + \beta 6SIZE_{i,t} + \beta 7LEV_{i,t} + \beta 8ROA_{i,t} + \beta 9GRW_{i,t} + \beta 10INT_{i,t} + \beta 11PPE_{i,t} + \beta 12AGE_{i,t} + \beta 13\sum ID + \beta 14\sum YD + \varepsilon_{i,t}$

<Research Model 7>

$BTD_{i,t} = \beta 0 + \beta 1CAPRND_{i,t} + \beta 2CAPRND2_{i,t} + \beta 3DON_{i,t} + \beta 4TOP_{i,t} + \beta 5MTB_{i,t} + \beta 6SIZE_{i,t} + \beta 7LEV_{i,t} + \beta 8ROA_{i,t} + \beta 9GRW_{i,t} + \beta 10INT_{i,t} + \beta 11PPE_{i,t} + \beta 12AGE_{i,t} + \beta 13\sum ID + \beta 14\sum YD + \varepsilon_{i,t}$

<Research Model 8>

Here,

$DDBTD_{i,t}$: Residual value after regressing total accrual on BTD (difference between accounting profit and taxable income),
$BTD_{i,t}$: Difference between accounting profit and taxable income,
$EXPRND_{i,t}$: Total R&D expenses treated as expenses,
$CAPRND_{i,t}$: Total development costs treated as assets
$DON_{i,t}$: Expenditures on corporate social responsibility activities (donations/sales),
$TOP_{i,t}$: Maximum shareholder equity ratio,
$MTB_{i,t}$: Corporate growth, market value of net assets/book value of equity,
$SIZE_{i,t}$: Corporate size, natural log of total assets at the end of the year,
$LEV_{i,t}$: Debt ratio, Liabilities at the end of the year/Total assets at the end of the year,
$ROA_{i,t}$: Total asset net income ratio, net income for the period/ Total assets at the beginning of the year,
$GRW_{i,t}$: Sales growth rate, (current period sales-previous period sales)/previous period sales,
$INTAN_{i,t}$: Intangible assets, Intangible assets/Total assets at the beginning of the year,
$PPE_{i,t}$: Capital intensity, (Tangible assets-Land-Construction in progress)/Total assets at the beginning of the year,
$AGE_{i,t}$: Natural logarithm of the year of establishment,
$\sum YD$: Year dummy,
$\sum ID$: Industry dummy,
$\mathcal{E}_{i,t}$: Error term.

3.3. Variable Description

3.3.1. Dependent variable: Tax evasion (BTD, DDBTD)

The main dependent variable of this study, tax avoidance, is measured in the following two ways.

1. Difference between accounting report profit and tax report profit (BTD)
2. The residual (DDBDT) after regressing the total accrual amount to the difference between accounting profit and tax profit (BTD).

First, the difference between accounting profit and tax profit (BTD) is calculated by deducting taxable income from net profit before income tax expense (Park, 2004; Desai and Dharmapala, 2006; Kim et al., 2019). Here, the taxable income is an estimated figure, and since the taxable income is not disclosed in the financial statements of Korea, it is calculated using the method used in previous studies (Park, 2004; Kim et al., 2019). Here, the difference between accounting profit and tax profit (BTD) is calculated as follows.

$$BTDit = AET - ETI$$

BTD: Difference between accounting profit and tax profit
AET: Net income before income tax
ETI: Estimated taxable income.

Then, taxable income is calculated by estimating it as follows (ETI).

$$ETI = \frac{CTB}{r}$$

ETI: Estimated taxable income
CTB: Corporate tax liability (Corporation tax expense + [Increase in deferred tax assets - Decrease in deferred tax assets] - [Increase in deferred tax liabilities - Decrease in deferred tax liabilities])
r: Annual corporate tax rate (1 + resident tax rate), 2000-2001: 30.8%, 2002-2004: 29.7%, 2005-2008: 27.5%, 2009-2017: 24.2%, 2018-2021: 27.5%, 2022-2023: 26.4%

Next, the residual after regressing the total accrual (TAC) on the difference between accounting profit and tax profit (BTD) is calculated as follows, and this is used as a proxy variable for tax avoidance (DDBTD).

$$BTDi,t = \beta 0 + \beta 1TACi,t + \varepsilon i,t$$

$$DDBTDi,t = \varepsilon i,t$$

BTD = (Profit before income tax expense - Estimated taxable income) ÷ total assets at the beginning of the year
TAC = Total accruals (Net income for the period - Cash flows from operating activities) ÷ total assets at the beginning of the year.

3.3.2. Independent variable

This study uses R&D expenses classified as expenses (EXPRND) and development costs classified as assets (CAPRND) as primary independent variables. EXPRND is calculated as the sum of research expenses, current R&D expenses, and development expenses from the income statement and manufacturing cost statement. CAPRND is derived by adding the depreciation of current development expenses to the value obtained by subtracting development expenses at the end of the current period from those at the end of the previous period (Jo and Choi, 2005; Kwon and Kim, 2010).

1. Total R&D expenses (EXPRND) treated as expenses = Research expenses, current R&D expenses, and current development expenses on the income statement + Research expenses and current development expenses on the manufacturing cost statement

2. Total development costs treated as assets (CAPRND) = Development expenses at the end of the current period – Development expenses at the end of the previous period + Amortization of development expenses for the current period.

3.3.3. Control variables

3.3.3.1. Donation (DON)

Donations are commonly used as a proxy for corporate ethics and social responsibility. Previous studies (Lee, 2014; Park et al., 2014) indicate a negative relationship between donations and tax avoidance. To account for their influence on tax avoidance behavior, this study includes donations as a control variable.

3.3.3.2. Top shareholder ownership ratio (TOP)

Jun (2011) finds that tax avoidance negatively affects firm value in companies with a top shareholder ownership ratio, while Yang (2022) reports that tax avoidance decreases in firms with high controlling shareholder concentration. To account for corporate governance effects on tax avoidance, this study includes the top shareholder ownership ratio as a control variable.

3.3.3.3. Market to book (MTB)

Market to book (MTB) is a ratio that compares market value to book value, indicating a company's future growth potential. Higher corporate growth is typically associated with higher corporate value (Kwon et al., 2016). This study includes MTB as a control variable to account for its potential effect on tax evasion.

3.3.3.4. Company size (SIZE)

Firm size (SIZE) can influence tax avoidance behavior. Kim (2017) finds that larger firms experience less negative impact from tax avoidance. Additionally, Cho et al. (2011) and Na et al. (2014) suggest that larger firms are more likely to engage in tax avoidance. Therefore, this study controls for firm size by using the natural logarithm of total assets.

3.3.3.5. Debt ratio (LEV)

The debt ratio (LEV) moderates the relationship between tax avoidance and firm value (Choi and Hong, 2018) and may also influence tax avoidance levels (Choi and Kweon, 2016). Therefore, this study includes the ratio of total debt to total assets as a control variable to account for its effect on tax avoidance.

3.3.3.6. Return on assets (ROA)

Return on assets (ROA), calculated by dividing accounting income by total assets, measures the proportion of net income generated from a company's assets. This profitability ratio is significantly related to an increase in future firm value (Yi, 2010). Therefore, the study includes ROA as a control variable to account for its potential effect on tax avoidance.

3.3.3.7. Sales growth rate (GRW)

Sales indicate the dominance of the products sold by a company in the market, and the sales growth rate also indicates the degree of dominance that a company has in the same industry. The study includes sales growth as a control variable to control for the possible impact of sales growth on the level of tax avoidance.

3.3.3.8. Intangible asset concentration (INTAN)

The concentration of intangible assets (INTAN) reflects their share in a company's total assets. Due to technological advancements, intangible assets now play a greater role in increasing corporate value than tangible assets (Kwon, 2009). Choi (2023) finds that industries with high intangible assets and technology focus yield higher returns.

3.3.3.9. Capital intensity (PPE)

Capital intensity (PPE) is calculated by subtracting assets under construction and land from total tangible fixed assets, then dividing by total assets at the start of the year. It reflects the proportion of assets invested in production and serves as an indicator of growth potential (Black et al., 2006; Park and Kwon, 2023). This study controls for its effect on tax avoidance.

3.3.3.10. Firm age (AGE)

Firm age (AGE) is associated with a company's survival ability and growth potential (Black et al., 2006). Sunwoo and Hyun (2017) note that manager age can influence tax avoidance. This study includes firm age as a control variable, calculated using the natural logarithm of the company's survival period.

3.3.3.11. Industry dummy (IND_D) and year dummy (YEAR_D)

This study includes industry dummy and year dummy as control variables to control the industry effect according to the characteristics and differences of the industry and the year effect that may occur according to the characteristics of each year.

4. EMPIRICAL ANALYSIS

4.1. Sample Selection

Table 2 shows the selection process of the sample data used in the empirical analysis of this study. Data for the analysis is sourced from the VALUESearch DB of NICE Information Service Co., Ltd. To ensure the accuracy and comparability of the results, the

Table 2: Sample selection procedure

Sample selection		Sample number (firm-year)
Number of extracted companies (2011-2023)		44,460
Excluded companies (−)	(1) Financial and insurance corporations (2) Companies that do not close their books at the end of December (3) Companies subject to management on the Stock Exchange or KOSDAQ (4) Companies with impaired capital (5) Companies with estimated taxable income of<0 (6) Companies with R&D expense or development cost related data<0 or missing (7) Companies with missing data on other empirical analysis variables	35,228
Number of companies included in the final analysis		9,232

study applies a strict sample selection process, excluding firms that meet specific conditions. The excluded firms are:

1. Financial and insurance companies, due to differing accounting standards.
2. Companies that do not close their books at the end of December, to avoid inconsistencies in financial data.
3. Firms under management by the Stock Exchange or KOSDAQ, as they may not comply with disclosure and reporting requirements.
4. Companies with impaired capital, reflecting financial instability.
5. Firms with estimated taxable income of <0, since they are unlikely to have tax avoidance motives.
6. Companies with R&D expenses or development cost data <0 or missing, as these figures are central to the study's focus.
7. Firms with missing data for other variables needed for the empirical analysis.

The exclusion criteria aim to create a homogeneous sample, reducing external influences that could distort the analysis. For instance, financial and insurance firms follow unique accounting rules, and firms with non-December fiscal year-ends may experience varying economic conditions. Moreover, companies with zero taxable income have minimal tax liabilities, weakening their incentive to engage in tax avoidance.

Additionally, outliers are removed by excluding firms with standardized residuals above 3 or Cook's distance over 1 during the first regression analysis. These steps ensure robust and reliable findings by focusing only on companies with consistent, relevant data.

Ultimately, this refined sample allows the study to better capture the true impact of R&D investments on corporate tax avoidance.

4.2. Descriptive Statistics

Table 3 presents the descriptive statistics of the key variables used in the study. The dependent variables, DDBTD and BTD, which serve as proxies for tax avoidance, have mean values of 0.07888 and 0.09492, with standard deviations of 0.09041 and 0.09254, respectively. The maximum values are 3.00909 and 1.93086. The main independent variables, R&D expenses (EXPRND) and development costs (CAPRND), have mean values of 0.03175 and 0.00478, with standard deviations of 0.23876 and 0.1132, and maximum values of 16.81832 and 10.73071, respectively.

For the control variables, the mean donation (DON) is 0.00112, with a standard deviation of 0.00511, while the largest shareholder's share (TOP) has a mean of 0.29711 and a standard deviation of 0.14786. The mean book value to market value ratio (MTB) is 1.78696, with a high standard deviation of 1.92359. Company size (SIZE) has a mean of 26.12087, with a standard deviation of 1.3976. The mean leverage ratio (LEV) is 0.21029, with a standard deviation of 0.18219, and the return on assets (ROA) has a mean of 0.07715 and a standard deviation of 0.12526.

Sales growth (GRW) has a mean of 0.18086 and a high standard deviation of 3.02365. The average value for intangible asset concentration (INT) is 0.03224, and capital intensity (PCIL) has a mean of 0.17914. The mean firm age (AGE) is 12.25344, with a standard deviation of 0.97615. These descriptive statistics provide a broad overview of the data used in the study and highlight significant variability in the key variables.

4.3. Correlation Analysis

Table 4 presents the results of the Spearman (below the diagonal) and Pearson (above the diagonal) correlation analysis between variables. The dependent variable, DDBTD, which proxies tax avoidance, shows a statistically significant positive correlation with BTD, EXPRND, CAPRND, MTB, ROA, GRW, and INTAN at the 1% level in the Pearson correlation analysis. It also shows a statistically significant negative correlation with SIZE, LEV, and AGE at the 1% level. However, DDBTD shows a statistically insignificant correlation with DON and PPE.

BTD shows a significant positive (+) correlation with DDBTD, CAPRND, MTB, ROA, and GRW at the 1% or 5% level, and a significant negative (−) correlation with SIZE, LEV, PPE, and AGE at the 1% level. However, BTD shows a statistically insignificant correlation with EXPRND, DON, TOP, and INTAN.

Spearman correlation analysis shows that DDBTD is not significantly correlated with CAPRND, DON, TOP, and PPE, but is significantly positively correlated with BTD, EXPRND, MTB,

Table 3: Descriptive statistics

Variable	Number	Mean	Standard deviation	Median	Minimum	Maximum
DDBTD	9.232	0.07888	0.09041	0.05711	0.0000202	3.00909
BTD	9.232	0.09492	0.09254	0.07369	0.0000188	1.93086
EXPRND	9.232	0.03175	0.23876	0.00564	0	16.81832
CAPRND	9.232	0.00478	0.1132	0	0	10.73071
DON	9.232	0.00112	0.00511	0.000185	0	0.33748
TOP	9.232	0.29711	0.14786	0.27395	0	0.926
MTB	9.232	1.78696	1.92359	1.24633	0.07708	40.95121
SIZE	9.232	26.12087	1.3976	25.88145	21.33556	33.19202
LEV	9.232	0.34224	0.18219	0.32545	0.0006171	0.9387
ROA	9.232	0.07715	0.12526	0.05812	−3.27181	3.19144
GRW	9.232	0.18086	3.02365	0.06184	−0.96873	281.3941
INTAN	9.232	0.03224	0.12004	0.01078	0	7.56623
PPE	9.232	0.17914	0.21432	0.14339	0	13.49112
AGE	9.232	12.25344	0.97615	12.3909	4.83628	16.82224

1) Variable description: See 3.2 Research model

Table 4: Correlation analysis

Variables	DDBTD	BTD	EXPRND	CAPRND	DON	TOP	MTB	SIZE	LEV	ROA	GRW	INTAN	PPE	AGE
DDBTD	1	0.78286	0.02983	0.06833	−0.00146	−0.02163	0.21881	−0.04584	−0.04329	0.11691	0.10049	0.02575	0.00723	−0.14014
		<0.0001	0.0041	<0.0001	0.8885	0.0377	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0133	0.4874	<0.0001
BTD	0.62833	1	0.02013	0.0706	0.01807	−0.01456	0.20169	−0.04899	−0.16197	0.39672	0.10937	0.00708	−0.06143	−0.13746
	<0.0001		0.0531	<0.0001	0.0826	0.162	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.4965	<0.0001	<0.0001
EXPRND	0.03498	0.06314	1	0.03224	0.11998	−0.04082	0.11182	−0.05189	−0.01794	−0.07193	0.001	0.02772	−0.01911	−0.03851
	0.0008	<0.0001		0.0019	<0.0001	<0.0001	<0.0001	<0.0001	0.0847	<0.0001	0.9235	0.0077	0.0663	0.0002
CAPRND	0.01109	−0.0396	0.23292	1	0.01352	−0.01666	0.02865	−0.00974	−0.0019	−0.01623	0.00082	0.17526	−0.00358	−−0.01233
	0.2865	0.0001	<0.0001		0.194	0.1094	0.0059	0.3493	0.8555	0.119	0.9373	<0.0001	0.7305	0.2361
DON	−0.0063	0.03706	0.02231	0.03569	1	−0.006	0.02835	0.05167	−0.03397	−0.00599	0.00415	0.02388	−0.00671	0.00721
	0.545	0.0004	0.0321	0.0006			0.0064	<0.0001	0.0011	0.5648	0.6905	0.0217	0.5193	0.4885
TOP	−0.01143	0.00428	−0.11255	−0.06118	0.00928	1	−0.01446	0.05033	−0.03979	−0.00058	0.00347	−0.00399	0.00922	−0.0121
	0.2723	0.6808	<0.0001	<0.0001	0.3727		0.1647	<0.0001	0.0001	0.9555	0.7386	0.7012	0.3755	0.2449
MTB	0.26059	0.31202	0.23136	0.12216	0.03967		1	−0.08898	0.03121	0.06895	0.04747	0.07924	0.00246	−0.12595
	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	−0.01706		<0.0001	0.0027	<0.0001	<0.0001	<0.0001	0.8133	<0.0001
SIZE	−0.05952	−0.07364	−0.17032	−0.03963	0.23935	0.1011	−0.17649	1	0.2086	−0.05429	0.0061	0.00442	0.10124	0.18953
	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	0.07117	<0.0001			<0.0001	0.5577	0.671	<0.0001	<0.0001
LEV	−0.09463	−0.27457	−0.12336	0.06394	−0.0593	<0.0001	0.00168	0.23142	1	−0.20278	0.00686	−0.0111	0.18789	0.00047
	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	−0.05178	0.8718	<0.0001		<0.0001	0.51	0.2863	<0.0001	0.9639
ROA	0.41914	0.7645	0.08477	−0.02063	0.05435	<0.0001	0.33581	−0.11166	−0.3437	1	0.06064	0.09943	0.16357	−0.11057
	<0.0001	<0.0001	<0.0001	0.0475	<0.0001	0.03889	<0.0001	<0.0001	<0.0001			<0.0001	<0.0001	<0.0001
GRW	0.12881	0.21139	0.04028	0.01652	−0.00967	0.0002	0.23628	−0.02224	0.05811	0.30369	1	0.01035	−0.0067	−0.01409
	<0.0001	<0.0001	0.0001	0.1125	0.3529	0.00078	<0.0001	0.0326	<0.0001	<0.0001			0.5199	0.1758
INTAN	0.078	0.03566	0.19984	0.43185	0.13948	0.94	0.2656	−0.08348	0.01105	0.11043	0.10555	1	0.1396	−0.04295
	<0.0001	0.0006	<0.0001	<0.0001	<0.0001	−0.0023	<0.0001	<0.0001	0.2885	<0.0001	<0.0001		<0.0001	<0.0001
PPE	0.01742	−0.10111	0.035	0.02597	0.06632	0.825	0.01106	0.14352	0.22077	−0.02112	0.05915	0.01459	1	0.01159
	0.0942	<0.0001	0.0008	0.0126	<0.0001	0.03474	0.288	<0.0001	<0.0001	0.0424	<0.0001	0.1611		
AGE	−0.1661	−0.17199	−0.20028	−0.12127	0.04786	−0.07743	−0.27931	0.28643	0.07276	−0.19913	−0.11176	−0.17	0.06248	1
	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	

1) Pearson correlation analysis above, Spearman correlation analysis below. 2) Description of variables: See 3.2 Research Model

ROA, GRW, and INTAN, and significantly negatively correlated with SIZE, LEV, and AGE.

BTD, another proxy variable for tax avoidance, shows a statistically significant positive (+) correlation with DDBTD, EXPRND, DON, MTB, SIZE, ROA, GRW, and INTAN at the 1% level, and a statistically significant negative (−) correlation with CAPRND, SIZE, LEV, PPE, and AGE at the 1% level, but shows a statistically insignificant correlation with TOP.

As a result of measuring the variance inflation factor (VIF) of all regression analyses, the maximum value of the variance inflation factor was <7, so it is thought that the possibility of multicollinearity occurring is very low.

4.4. Results of Regression Analysis

Table 5 presents the results of empirical analysis using research models 1 and 2 to examine the impact of R&D expenses and development costs on tax avoidance (DDBTD). Model 1 investigates the effects of R&D expenses, while Model 2 focuses on development costs. Both models show statistically significant F-values (88.46 and 88.19) at the 1% level, with Adj-R2 values of 0.2085 and 0.2080, indicating moderate explanatory power. The maximum variance inflation factor (VIF) is 1.20727 in both models, suggesting minimal multicollinearity.

In Model 1, R&D expenses (EXPRND) have a positive and statistically significant coefficient (0.00817) at the 1% level. Control variables such as MTB, SIZE, ROA, PPE, and AGE show significant positive coefficients, while LEV exhibits a significant negative coefficient. In Model 2, development costs (CAPRND) have a negative and significant coefficient (-0.09562), indicating an inverse relationship with tax avoidance. MTB, ROA, and PPE are positively significant, while LEV and AGE show negative coefficients.

These findings suggest that R&D expenses significantly influence tax avoidance in Korean listed companies, supporting Hypothesis 1, while development costs do not show a significant relationship, failing to support Hypothesis 2. The results align with previous studies by Kim et al. (2019) and Ma and Yoo (2020), which report that R&D expenses are associated with increased tax avoidance. Thus, R&D expenses contribute to tax avoidance strategies, while development costs do not.

Table 6 presents the empirical analysis results on the impact of R&D expenses and development costs on tax avoidance (BTD) using research models 3 and 4. Model 3 analyzes the effect of R&D expenses, while Model 4 investigates the impact of development costs. Both models show statistically significant F-values (532.76 and 524.29) at the 1% level, with adjusted R^2 values of 0.6153 and 0.6116, indicating strong explanatory power, about 3 times larger than in previous models. The maximum variance inflation factor (VIF) is 1.24552 for both models, suggesting minimal multicollinearity.

In Model 3, the coefficient for R&D expenses (EXPRND) is 0.02528, significant at the 1% level. Control variables MTB, SIZE, and ROA show significant positive coefficients, while LEV, GRW, INTAN, PPE, and AGE show significant negative coefficients. In Model 4, the coefficient for development costs (CAPRND) is −0.0483, significant at the 5% level. Control variables DON, MTB, SIZE, and ROA are positively significant, while LEV, GRW, INTAN, PPE, and AGE exhibit negative coefficients.

The findings indicate that R&D expenses are significantly related to tax avoidance (BTD) in Korean listed companies, supporting Hypothesis 1, but development costs do not have a significant

Table 5: Analysis of the relationship between R&D investment and tax avoidance (DDBTD): R&D expense versus Development cost

Variable	Dependent variable (DDBTD)							
	<Research model 1>				<Research model 2>			
	Coefficient	t-value	Pr > |t|	Variance inflation factor (VIF)	Coefficient	t-value	Pr > |t|	Variance inflation factor (VIF)
(Constant)	0.10689	8.96	<0.0001	0	0.11252	9.46	<0.0001	0
EXPRND	0.00817	3.53	0.0004	1.05335				
CAPRND					−0.09562	−3.25	0.0012	1.08608
DON	−0.01692	−0.16	0.8708	1.02872	0.01937	0.19	0.8511	1.01351
TOP	−0.00313	−0.86	0.3908	1.02122	−0.00411	−1.13	0.2585	1.02162
MTB	0.00692	19.85	<0.0001	1.18699	0.00722	20.74	<0.0001	1.18641
SIZE	0.000879	2.17	0.0304	1.13448	0.000769	1.9	0.0578	1.13281
LEV	−0.01082	−3.37	0.0007	1.20658	−0.01133	−3.54	0.0004	1.20571
ROA	0.18264	31.4	<0.0001	1.20727	0.17867	30.91	<0.0001	1.19373
GRW	−0.00076	−0.74	0.4595	1.10446	−0.001	−0.97	0.331	1.10434
INTAN	−0.00704	−1.55	0.1215	1.02276	−0.00467	−1.01	0.3137	1.06234
PPE	0.01426	4.16	<0.0001	1.09722	0.01389	4.05	<0.0001	1.09843
AGE	−0.00676	−11.57	<0.0001	1.08982	−0.00691	−11.84	<0.0001	1.09093
Year dummy			Included				Included	
Industry dummy			Included				Included	
F-Value			88.46***				88.19***	
Adj-R2			0.2085				0.2080	
Number of samples after removal of outliers			8.967				8.965	

1) Description of variables: See 3.2 Research model

Table 6: Analysis of the relationship between R&D investment and tax avoidance (BTD): R&D expense versus Development cost

Variable	Dependent variable (BTD)							
	<Research model 3>				<Research model 4>			
	Coefficient	t-value	Pr > |t|	Variance inflation factor (VIF)	Coefficient	t-value	Pr > |t|	Variance inflation factor (VIF)
(Constant)	0.05624	6.22	<0.0001	0	0.06484	7.16	<0.0001	0
EXPRND	0.02528	8.5	<0.0001	1.1093				
CAPRND					−0.0483	−2.11	0.0345	1.12775
DON	0.06409	0.8	0.4262	1.05949	0.20572	2.6	0.0093	1.01357
TOP	−0.00183	−0.66	0.5074	1.02191	−0.00357	−1.29	0.1976	1.02192
MTB	0.00403	16.08	<0.0001	1.20841	0.00458	18.25	<0.0001	1.19899
SIZE	0.00197	6.42	<0.0001	1.1356	0.0018	5.85	<0.0001	1.13276
LEV	−0.02666	−10.81	<0.0001	1.24055	−0.02815	−11.39	<0.0001	1.23581
ROA	0.48159	96.84	<0.0001	1.24552	0.47355	95.23	<0.0001	1.22473
GRW	−0.00205	−3.39	0.0007	1.06536	−0.00215	−3.54	0.0004	1.06636
INTAN	−0.03504	−10.13	<0.0001	1.02269	−0.04145	−8.37	<0.0001	1.1028
PPE	−0.02656	−10.27	<0.0001	1.1022	−0.02663	−10.25	<0.0001	1.10229
AGE	−0.00412	−9.31	<0.0001	1.09634	−0.00432	−9.73	<0.0001	1.09738
Year dummy			Included				Included	
Industry dummy			Included				Included	
F-value			532.76***				524.29***	
Adj-R2			0.6153				0.6116	
Number of samples after removal of outliers			8.977				8.975	

1) Description of variables: See 3.2 Research model

effect, failing to support Hypothesis 2. These results align with Kim et al. (2019) and Ma and Yoo (2020), who report a positive relationship between R&D expenses and tax avoidance.

Table 7 presents the results of empirical analysis using research models 5 and 6 to examine whether the relationship between R&D expenses and development costs on tax avoidance (DDBTD) is linear or nonlinear. Research model 5 includes the square of R&D expenses ($EXPRND^2$), while research model 6 includes the square of development costs ($CAPRND^2$). Both models demonstrate statistically significant results at the 1% level, with F-values of 85.94 and 85.44, respectively. The adjusted R^2 values for the models are 0.2096 and 0.2087, indicating moderate explanatory power. The variance inflation factor (VIF) values for both models are below 6.19, suggesting low multicollinearity.

In model 5, the coefficient of R&D expenses (EXPRND) is insignificant, while the square of R&D expenses ($EXPRND^2$) has a significant negative coefficient (−0.0016) at the 1% level. Control variables such as MTB, SIZE, ROA, and PPE show significant positive coefficients, whereas LEV and AGE have significant negative coefficients. The findings suggest that the relationship between R&D expenses and tax avoidance is nonlinear, following an inverted U-shaped curve.

For model 6, both the coefficient of development costs (CAPRND) and its square ($CAPRND^2$) are statistically insignificant. Control variables such as MTB, SIZE, ROA, and PPE exhibit positive relationships with tax avoidance, while LEV and AGE have negative associations.

These results indicate that in the Korean stock market, R&D expenses increase tax avoidance up to a certain threshold, beyond which they reduce tax avoidance, supporting Hypothesis 3 (a nonlinear relationship between R&D expenses and tax avoidance). However, the findings do not support Hypothesis 4, which posits that development costs have a nonlinear relationship with tax avoidance. The study concludes that tax avoidance in Korean listed companies is driven by R&D expenses, but not by development costs. These results are consistent with prior studies by Kim et al. (2019) and Ma and Yoo (2020), which also identified an inverted U-shaped relationship between R&D expenses and tax avoidance.

Table 8 presents the results of empirical analysis using research models 7 and 8 to examine whether the relationship between R&D expenses and development costs on tax avoidance (BTD) is linear or nonlinear. Research model 7 includes the square of R&D expenses ($EXPRND^2$), while research model 8 includes the square of development costs ($CAPRND^2$). The F-values for both models, 511.26 and 505.91, are statistically significant at the 1% level, with adjusted R^2 values of 0.6141 and 0.6118, respectively, which are significantly higher than those of research models 5 and 6. The variance inflation factor (VIF) values are below 6.73, suggesting low multicollinearity.

In the analysis of model 7, the coefficient for R&D expenses (EXPRND) is significantly positive (0.04148), while the coefficient for the square of R&D expenses ($EXPRND^2$) is significantly negative (−0.00196), indicating an inverted U-shaped relationship. Control variables such as MTB, SIZE, and ROA show positive coefficients, while LEV, GRW, INTAN, PPE, and AGE show negative coefficients.

For model 8, the coefficient for development costs (CAPRND) is significantly negative (−0.13441), and the square of development costs ($CAPRND^2$) is statistically insignificant (0.19849). Control

Table 7: Verification of the nonlinear relationship between R&D investment and tax avoidance (DDBTD): R&D expense versus development cost

Variable	Dependent variable (DDBTD)							
	<Research model 5>				<Research model 6>			
	Coefficient	t-value	Pr > |t|	Variance inflation factor (VIF)	Coefficient	t-value	Pr > |t|	Variance inflation factor (VIF)
(Constant)	0.10306	8.62	<0.0001	0	0.10825	9.07	<0.0001	0
EXPRND2	−0.0016	−3.95	<0.0001	5.93069				
EXPRND	0.02981	5.46	<0.0001	6.18663				
CAPRND2					−0.01506	−0.1	0.9213	2.99139
CAPRND					−0.09719	−1.93	0.0533	3.16295
DON	−0.10189	−0.96	0.3349	1.06065	0.02349	0.23	0.82	1.01395
TOP	−0.00244	−0.67	0.504	1.02368	−0.00378	−1.04	0.2988	1.02207
MTB	0.00669	18.97	<0.0001	1.21557	0.00737	20.87	<0.0001	1.18934
SIZE	0.000954	2.35	0.0189	1.1368	0.000826	2.04	0.0418	1.13372
LEV	−0.01026	−3.2	0.0014	1.21079	−0.01125	−3.51	0.0004	1.20588
ROA	0.18505	31.64	<0.0001	1.22152	0.17908	30.97	<0.0001	1.19524
GRW	−0.00093	−0.91	0.3615	1.10502	−0.00084	−0.82	0.4096	1.10581
INTAN	−0.00778	−1.71	0.0875	1.02417	−0.00377	−0.81	0.4182	1.0743
PPE	0.01452	4.23	<0.0001	1.09753	0.01391	4.05	<0.0001	1.09969
AGE	−0.00666	−11.39	<0.0001	1.0916	−0.00672	−11.48	<0.0001	1.09367
Year dummy			Included				Included	
Industry dummy			Included				Included	
F-value			85.94***				85.44***	
Adj-R2			0.2096				0.2087	
Number of samples after removal of outliers			8.968				8.965	

1) Description of variables: See 3.2 Research model

Table 8: Verification of the nonlinear relationship between R&D investment and tax avoidance (BTD): R&D expense versus development cost

Variable	Dependent variable (BTD)							
	<Research model 7>				<Research model 8>			
	Coefficient	t-value	Pr > |t|	Variance inflation factor (VIF)	Coefficient	t-Value	Pr > |t|	Variance inflation factor (VIF)
(Constant)	0.05427	5.98	<0.0001	0	0.06608	7.3	<0.0001	0
EXPRND2	−0.00196	−6.11	<0.0001	6.46461				
EXPRND	0.04148	9.42	<0.0001	6.72611				
CAPRND2					0.19849	1.71	0.088	2.88911
CAPRND					−0.13441	−3.47	0.0005	3.14164
DON	0.01766	0.22	0.8274	1.06721	0.20202	2.56	0.0105	1.014
TOP	−0.00127	−0.46	0.646	1.02386	−0.00324	−1.17	0.2415	1.02238
MTB	0.004	15.86	<0.0001	1.22019	0.0047	18.61	<0.0001	1.20218
SIZE	0.00202	6.53	<0.0001	1.13686	0.00177	5.75	<0.0001	1.13368
LEV	−0.02601	−10.51	<0.0001	1.24357	−0.02826	−11.45	<0.0001	1.23582
ROA	0.48138	96.38	<0.0001	1.24847	0.47211	94.94	<0.0001	1.22586
GRW	−0.00206	−3.39	0.0007	1.06577	−0.00207	−3.42	0.0006	1.06678
INTAN	−0.04078	−8.66	<0.0001	1.02751	−0.03564	−7.25	<0.0001	1.11906
PPE	−0.02661	−10.27	<0.0001	1.10118	−0.02668	−10.28	<0.0001	1.10361
AGE	−0.00409	−9.23	<0.0001	1.09855	−0.00436	−9.83	<0.0001	1.09974
Year dummy			Included				Included	
Industry dummy			Included				Included	
F-value			511.26***				505.91***	
Adj-R2			0.6141				0.6118	
Number of samples after removal of outliers			8.978				8.972	

1) Description of variables: See 3.2 Research model

variables MTB, SIZE, and ROA exhibit positive relationships with tax avoidance, while LEV, GRW, INTAN, PPE, and AGE have negative relationships.

The results indicate that R&D expenses increase tax avoidance up to a certain point, beyond which they reduce tax avoidance, supporting Hypothesis 3 (nonlinear relationship between R&D expenses and tax avoidance). However, the findings show a linear negative relationship between development costs and tax avoidance, not a nonlinear one, which does not support Hypothesis 4. These results are consistent with previous studies (Kim et al., 2019; Ma and Yoo, 2020) that also found an inverted U-shaped relationship between R&D expenses and tax avoidance in the Korean stock market.

5. CONCLUSION

Under the Korean International Financial Reporting Standards (K-IFRS) and the Corporate Tax Act, R&D investments can be recorded as either current expenses or intangible assets. R&D expenses treated as expenses under K-IFRS are deductible under the Corporation Tax Law, reducing taxable income. Development costs, treated as intangible assets, can be depreciated and deducted in future periods, further reducing taxable income. Korea also offers various tax incentives for R&D, allowing tax benefits like deductions for R&D expenses up to a certain amount. These time differences in tax benefits may incentivize companies to use R&D investment for tax avoidance, necessitating an examination of the relationship between selective R&D accounting and tax avoidance.

From this perspective, this study examines the impact of R&D investment on tax avoidance for companies listed on the Korean stock market from 2011 to 2023. It explores differences between R&D expenses expensed in the current period and development costs capitalized as intangible assets. The study also investigates whether the relationship between R&D expenses and tax avoidance is one-way or two-way. Four hypotheses are proposed, with eight research models designed to test these hypotheses through empirical analysis.

The results of the empirical analysis support Hypothesis 1 <R&D expenses are significantly related to tax avoidance.>, Hypothesis 2 <Development costs are significantly related to tax avoidance.>, and Hypothesis 3 <R&D expenses are nonlinearly related to tax avoidance.>, but Hypothesis 4 <Development costs are nonlinearly related to tax avoidance.> is not supported.

The results of the empirical analysis of this study show that companies in the Korean capital market use R&D investment to avoid taxes, and in particular, they mainly use R&D expenses treated as expenses rather than development costs treated as assets. In addition, R&D expenses are used for tax avoidance or play a role in increasing tax avoidance when they are below a certain level, but there is an inverted U-shaped correlation that reduces tax avoidance when it exceeds a certain level.

This finding aligns with previous studies on the relationship between tax avoidance and R&D expenses (Kim et al., 2019; Ma and Yoo, 2020). The results suggest that tax avoidance in the Korean capital market is primarily driven by R&D expenses. While excessive R&D expenses below a certain threshold are used for tax avoidance, R&D expenses exceeding this threshold actually reduce tax avoidance.

The study is expected to provide a new perspective on R&D investment used by companies as a means of tax avoidance by clarifying the form of the relationship between R&D expenses and tax avoidance. However, this study has a limitation in that it did not empirically verify the specific cause of the nonlinear relationship between R&D expenses and tax avoidance. Therefore, it is necessary to conduct follow-up research to clarify this cause.

5.1. Data Availability Statement

The data that support the findings of this study are available from NICE Information Service Co., Ltd. (https://www.niceinfo.co.kr/main.nice). Restrictions apply to the availability of these data, which were used under license for this study. Data are available from VALUESearch DB homepage (https://valuesearch.co.kr/) with the permission of NICE Information Service Co., Ltd.

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