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Capital structure and innovation for social progress: How high-tech firms shape economic development and institutional resilience in China

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Abstract

This study investigates how capital structure and R&D investment strategies in high-tech listed companies contribute not only to firm performance but also to broader economic development and institutional resilience in China. In the face of a competitive global landscape that is intensifying and rapidly evolving technologically, high-tech enterprises are positioned as key actors in fostering innovation-driven growth, economic upgrading, and inclusive social progress. The empirical nature of the research involves examining financial information from high-tech companies to analyze the relationship between capital structure, R&D investment, firm size, and firm performance over a period of five years. This study adopts a quantitative approach by applying multiple regression analysis to measure the relationship between the independent variables and firm performance. More importantly, investment in R&D not only enhances innovation capacity and market adaptability but also reinforces national objectives related to technological self-reliance, green transformation, and the Sustainable Development Goals (SDGs). Grounded in both literature and practice, this study links several bodies of literature that have so far remained largely separate: corporate finance, strategic management, and innovation management. The findings contribute to ongoing debates on the role of private-sector financial strategies in achieving structural transformation, innovation, equity, and institutional strengthening in emerging economies. The results highlight the significance of maintaining a balanced capital structure and strategic investment in R&D to spur sustainable growth within high-tech industries. This research offers actionable insights for policymakers seeking to harness firm-level innovation for societal advancement and sustainable economic development.

Keywords: Capital structure, China, Economic transformation, High-tech industry, Innovation policy, Institutional resilience, Quality jobs, R&D investment, Sustainable growth.

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1. Introduction

1.1. The Current State of Global High-Tech Companies

High-tech enterprises are facing significant domestic and international competition, globalization, and rapid technological evolution. To ensure a competitive edge, continued innovation has become a crucial factor for the survival and development of enterprises, especially in high-technology companies [1]. R&D investment scale and efficiency have a direct impact on the innovation and development of high-tech enterprises and their ability to deal with market risk, as the main engine of high-tech enterprises on the road to technological innovation. Yet, R&D often comes with a large capital investment and has the drawbacks of a long payback period and high risk, which makes it necessary for modern-day enterprises to have a good capital structure to support their R&D strategy implementation.

This can alleviate the pressure of capital, reduce the cost of capital, and then affect the investment decision and long-term development of enterprises. In higher-tech companies, the capital-intensive characteristics make the capital structure choice more significant [2]. Operating performance, as one of the key criteria used to assess the outcomes of corporate business activities, is widely evaluated through financial and non-financial indicators [3]. Since high-tech companies usually cover fast technological updates and selection, and large changes in market demand, the operating performance can particularly reflect the responsiveness to market dynamics and the efficiency of internal management of the company. Understanding the impact of capital structure and R&D investment behavior on the operational performance of high-tech enterprises not only helps corporate executives to adjust strategic transformation but also serves as a basis for companies to achieve sustainable innovation and healthy development, and provides a reference for decision makers to roll out relevant industry policies, especially under economic transformation and industry upgrading conditions [4]. Through empirical analysis and systematic theoretical analysis, this study attempts to identify the specific influence of R&D investment on the operating performance of high-tech enterprises in different capital structures.

1.1.1. Background of China's High-Tech

The development history of China's high-tech enterprises has undergone tremendous growth and change, thus becoming an important part of economic globalization. China will deepen the application of the "Made in China 2025" strategy and promote development through innovations from a policy perspective. In response to the uncertain international economic environment, China has proposed the "dual circulation" strategy, which is a new development pattern featuring domestic circulation as the main body and international and domestic circulations reinforcing each other. The country has emphasized environmental protection and sustainable development as core strategies, enacted a series of environmental protection laws and policies, promoted green manufacturing and low-carbon economic development, and encouraged companies to utilize clean energy and energy-saving technologies. Technologies such as industrial robots, artificial intelligence, e-commerce, and new retail models have transformed the conventional sales model for high-tech enterprises. Driven by factors like the epidemic and geopolitics, the global supply chain is exhibiting a trend of adjustment and reorganization. China's high-tech companies need to withstand the chaotic external environment with a more resilient and flexible supply chain. As the economy grows and the overall living standards of Chinese people improve, the cost of labor in China continues to increase, placing certain cost pressures on high-tech enterprises [5]. In response to the demand for intelligent manufacturing and the information technology revolution, the labor market tends to focus more on the training of employee skills and vocational education, which greatly improves the skilled personnel level and innovative ability of enterprises. Over the past five years, under the guidance of technological advancements, policy benefits, market demand changes, and global supply chain restructuring, the transformation and upgrading of high-tech enterprises in China have made tremendous progress. Through technological innovation, improving production efficiency, and enhancing international competitiveness, companies are responding to new challenges and opportunities and practicing high-quality and sustainable development.

1.2. Problem Statement

High-tech companies are faced with fierce international competition and technological innovation in the global economy of today. Such companies must have ongoing investment in research and development (R&D) to foster innovation, build competitive advantages, and respond to fluctuations in the marketplace. In parallel, capital structure, being the essence of corporate financial decision strategy and decision-making, has a decisive impact on the company's risk

management, cost efficiency, and long-term development strategy. Hence, it is important to investigate how the capital structure and R&D investment impact the operating performance of listed companies, which is conducive to an overall understanding of the financial and operational characteristics of the high-tech industry. This study intends to answer the following questions: Capital structure is negatively correlated with the operating performance of high-tech listed companies. The effect of research and development (R&D) investment on the operational performance of high-tech listed corporations: What is the relationship between the scale and efficiency of R&D investment and the company's capacity for innovation, competitiveness of products, and market adaptiveness? Companies of different sizes differ greatly in resource acquisition, market competition, and operational management. Such differences can result in different performances among companies.

1.3. Research Question

This study selected A-share high-tech listed companies as the research object. Data from 2018 to 2022 were selected as the observation range. To ensure the accuracy and stability of the data, data screening was carried out according to the following principles: (1) To ensure data stability, ST companies and ST companies were excluded; (2) Data abnormalities or serious missing data were also excluded. To avoid the influence of extreme outliers, all continuous variables were minorized by 1% above and below. All data sorting, summary, and analysis work were completed using Excel and SPSS 26 software. The data came from the database of professional institutions. Data on corporate operating performance, capital structure, R&D investment, and control variables were all sourced from the CSMAR database.

1. Does capital structure have an impact on company performance?
2. Does R&D investment have an impact on company performance?
3. Does company size have an impact on company performance?

1.4. Research Objectives

The purpose of this study is to investigate the influences that affect the performance of high-tech companies. The dependent variable is the change in the performance of high-tech companies. Changes in capital structure, the amount of R&D investment, and company size are the independent variables that affect company performance. The following are the initial objectives set:

RO1: To examine the impact of capital structure on company performance.
RO2: To examine the impact of R&D investment on company performance.
RO3: To examine the impact of different company sizes on company performance.

Helping a company understand the impact of capital structure, research and development investment, and company size on company performance is more conducive to grasping its own development direction, finding the development focus of each company according to its needs, and facilitating the formulation of suitable development methods to improve company performance.

1.5. Significance

1.5.1. Theoretical significance

The traditional financial theory examines the risk and returns of capital structure, while the innovation management theory emphasizes the effectiveness and efficiency of R&D investment. A significant econometric study for private entities' money from venture capital, with the main purpose of researching the effect of corporate performance and the capital structure to deal with the state of corporate R&D investment, verified the factors that affect direct R&D. This study contributed significantly to related research, helping to deepen the understanding of the economic effects of R&D activities by exploring the impact of R&D investment on corporate performance through technical efficiency, product innovation, and market adaptability under different adjustments of capital structure.

The interdependence of macroeconomic policy environment and company behavior in innovation adjustment and financial strategy adjustment can provide necessary theoretical enlightenment for policymakers and corporate managers to understand how the company can cope with the external situation. The above research aims to be a more in-depth theoretical exploration of capital structure and R&D management and provide a theoretical basis and data reference for later research development, to promote the development and perfection of relevant theories.

1.5.2. Practical significance

This innovative exploration of capital structure and R&D investment influences the operating performance of high-tech enterprises but also has important practical significance. The findings will enable corporate management to better understand the mechanisms through which capital structure and R&D investment affect operating performance, thus leading to more scientific financial decision-making and R&D strategy planning in practice [6]. A judicious balance between debt and equity financing can enable companies to better fund R&D efforts, thereby improving innovative potential and ultimately resulting in improved competitiveness in the market. It conducts an empirical analysis of the relationship between capital structure, R&D investment, and operating performance of high-tech companies, which is an important reference value for investors to evaluate corporate value and investment risk. The financial structure and R&D investment of companies enable investors to predict their future development potential and rate of return more accurately. The research findings can assist policymakers in understanding the investment dynamics of high-tech companies under various capital structures, enabling them to devise industrial policies and fiscal and taxation incentives that promote corporate innovation and the healthy development of the high-tech enterprise sectors.

1.6. Scope and Limitations of the Study

With the latter factor emphasized more specifically when it comes to the effect of high-tech companies, this study aims to investigate the impact of capital structure and R&D investment on operating performance in the case of listed companies. The study is confined to specific areas listed as follows.

Discover the correlation between capital structure stability and the technology industry's operational performance, including the effects that the debt-equity ratio can have on company profitability and market competitiveness. This assesses how the scale and efficiency of R&D investments affect the competitiveness of the company's products and their adaptability to the market. It analyzes the differences in company size and nature in resource acquisition, market competition, and operating management, and how these differences influence the company's operating performance. Because research data were collected from 2018 to 2022, this period demonstrates the influence of capital structure and R&D investment on operating performance. The subjects of the research are restricted to China's A-share listed manufacturing companies, which may limit the applicability of the results to other regions. Since the research targets the high-tech industry, its findings may not be entirely relevant in other sectors. The data provided by the CSMAR database could be limited at certain times in terms of coverage and quality. This sample is limited to China's A-share listed companies and may not fully capture the heterogeneity among global high-tech companies. The research covers data between 2018 and 2022 and does not necessarily reflect recent market shifts or regulatory impacts. The analysis controlled for variables such as company size, operating income growth rate, and years of listing, but other unobserved external variables may still influence the results. This study is observational, and causal inferences related to the data cannot be definitively established.

This helps the study to specify its objectives and appropriately navigate between its respective limitations and implications, with four main limitations noted: The study intended to enhance understanding of the effect of capital structure, research and development expenditure, and firm size on firm performance in high-tech companies, even as it recognizes that there is a limited generalizability of the results outside the factors mentioned above. Further studies can verify and generalize the results of this study by broadening the sample scope, extending the data collection time, and accounting for more control variables.

1.7. Definition of Terms

Table 1.
Variable definition table.

Variable type	Variable name	Variable symbol	Variable definitions
Explained variable	Return on assets	ROA	(Total profit ÷ total assets)100% =Return on total assets
Explanatory variables	R&D investment intensity	RDI	R&D expenditure/operating income
	Long-term gearing ratio	DEBT	([Non-current liabilities/ (non-current liabilities + shareholders' equity)] ×100%
Control variables	Operating income growth rate	RGR	Growth ratio of operating income for the current period to operating income for the previous period
	Company size	ES	natural logarithm of total assets
	Years on the market	LY	Number of years since the company went public

2. Literature Review

2.1. Underpinning Theories

2.1.1. Modigliani-Miller Theorem

The MM Theorem, proposed by Modigliani and Miller, states that a firm's value in a perfect market is independent of its capital structure [7]. Their new model (1963) included tax shields and argued that by reducing tax liabilities, debt financing increases firm value because capital costs can be minimized.

This theory aligns with the goal of the study concerning minimizing costs, which is conceptually achieved through Optimal Capital Structure (such as debt ratio or debt-equity ratio) to maximize profitability. For instance, high-tech companies use cheap debt during growth periods to generate increased returns on equity for shareholders, which is consistent with the tax shield effect.

Such divergence between financial leverage and ROA remains positive within the macroeconomic and structural characteristics of the high-tech industry, predicated upon a balanced risk approach.

2.1.2. Dynamic Trade-Off Theory

Firms dynamically adjust capital structures to balance the tax benefits of debt against bankruptcy risks [8].

High-tech companies prioritize equity financing during economic downturns to avoid fixed interest burdens, while favoring debt in growth phases to exploit tax shields. Research on Chinese A-share firms reveals an inverted U-shaped relationship between debt ratios and ROA, indicating optimal leverage thresholds [9].

2.1.3. Economies of Scale Theory

Larger firms reduce unit costs through mass production, bulk purchasing, and resource allocation efficiencies [10].

The study posits that scale enables high-tech firms to fund R&D, negotiate favorable supplier terms, and diversify risks (e.g., Alphabet's ventures in autonomous driving and biotech).

Audretsch et al. [11] find that firms with assets >$1B invest 3× more in R&D than SMEs, directly boosting market share and profitability [11].

2.1.4. Agency Cost Theory

Conflicts between managers and shareholders may lead to suboptimal decisions, such as underinvestment in R&D to meet short-term profit goals [12].

The study acknowledges that excessive debt may pressure managers to cut R&D budgets, harming long-term innovation [13].

Research on Nasdaq-listed firms shows that high-leverage companies exhibit 15% lower R&D intensity compared to low-debt peers.

These theoretical foundations guide the empirical analysis in subsequent chapters, linking financial strategy, innovation, and scale to high-tech firms' operating outcomes.

2.2. The Relationship between Independent and Dependent Variables

This section will explore the theoretical and empirical links between the independent variables (capital structure, R&D investment, and firm size) and the dependent variable (operating performance of listed high-tech firms).

2.2.1. Capital Structure and Operating Performance

A suitable capital structure can help a company improve its profitability and competitiveness in the market, while an unsuitable capital structure can cause the company to face problems such as an excessive debt ratio, which will have adverse effects on the company's performance. With good performance comes creditworthiness, which is the best business card for a good company. This would allow these companies to have good financing channels and enjoy preferential financing rates in the financing market.

2.2.2. R&D Investment and Operating Performance

Research and development (R&D) investment is an essential means for enterprises to adapt to and lead the market. Companies tend to enhance existing products and services, develop new products and technologies, thus increasing their market share and strengthening their competitiveness through ongoing R&D. R&D investment refers to funds spent not only on research and development for technology but also on product design, process improvement, quality control, etc.

2.2.3. Company Size and Operating Performance

The size of a company is often considered a key factor in its competitiveness and market performance. Larger companies can take advantage of economies of scale, reduce unit costs, and increase market competitiveness. Large companies generally have stronger market influence and brand recognition, which helps attract more customers and business. Larger companies generally have easier access to capital and other resources, including talent, technology, and funding.

2.3. The Stability of Capital Structure Has a Positive and Significant Impact on Company Performance

The capital structure, in other words, the structure of how and in what proportions a company is financed, deeply affects the performance of a company. Capital structure can play a role in enhancing the profitability and market competitiveness of an enterprise, while an unreasonable capital structure is likely to produce many problems for the enterprise, such as a high debt ratio, which adversely impacts the performance of an enterprise. Corporate performance affects capital structure. If the company has performed well, it can increase the credibility of the company, enhance financial results, and have better financing channels and lower market interest rates in the financing market. Conversely, if a business is not doing well, it will make the credibility of financing channels unstable and even lead to a financial crisis. The choice of capital structure and its efficiency will be influenced by industry characteristics, company size, and the level of development of the capital market. For instance, fast-growing sectors might choose equity financing to address their working capital requirements, while mature industries might lean towards debt financing to lower their financing expenses in a bid to boost shareholder returns. To sum up, the relationship between capital structure and corporate performance is two-way, interactive, and mutually influential. Companies must decide the optimal capital structure according to their own situation and market needs to maximize performance. There is academic research that supports this conclusion. For example, "Meta-Analysis of Capital Structure and Corporate Performance," published in 2020, found a negative correlation between corporate performance and capital decisions, indicating that capital structure decisions have a significant impact on corporate performance [14]. Also, according to the Modigliani and Miller [7] theorem proposed by Modigliani and Miller [7] initially, the capital structure was thought to have no impact on corporate value. In their other view in 1963, however, they argued that when tax relief expenses are taken into account, the growth of interest could decrease taxes paid, and thus help improve the cash flow of the company, resulting in a positive relationship between corporate value and financial leverage [15]. Evidence of an efficient capital structure that translates to lower capital costs and improved financial performance for companies.

In the real world, many firms optimize their capital structure to improve performance. To magnify shareholder returns, some technology companies may prefer more debt financing during times of low interest rates, utilizing the

financial leverage effect. Conversely, in a recession, businesses might opt for equity financing rather than debt financing to avoid the burden of fixed interest payments and to maintain financial safety and performance.
Therefore, the stability of capital structure positively and significantly relates to corporate performance. Instead, companies must select the right capital structure for themselves from all available options, considering their unique situation and current market conditions, to enhance their performance.

H_1: The stability of capital structure has a positive and significant impact on company performance

2.4. R&D Investment Has a Positive and Significant Impact on Company Performance

Sukumar states that R&D investment can have a significant positive influence on the development of firm innovation and firm competitiveness [16]. Investment in research and development (R&D) is one of the important ways for enterprises to adapt and lead the market. Research and development not only allows companies to improve the quality of existing products and services and helps to develop new products and technologies but also expands market share and enhances competitiveness. Such investment enables enterprises to absorb talents and technical resources, promote employees' skills to be improved, and increase the technical reserves of the enterprise, which is of great significance to the construction of core competitiveness [17]. As evident, R&D investment encompasses not only technology R&D but also other aspects of product design, process improvement, quality, etc [18]. By continually investing in R&D, firms can enhance product design and manufacturing processes to improve product quality and performance, as well as service levels to meet different consumers' needs and help enhance the competitiveness of firms. However, we also need to consider that through continuous investment in R&D, companies can launch innovative products and technologies, seizing market opportunities and gaining more market share [19]. The significant return on long-term investment is primarily due to the positive impact of R&D investment on the market value of high-tech companies. Investment in R&D tends to lead to the development of new products, new technologies, or new processes that can create competitive advantages and capture larger market shares. In short, it has an all-round influence on companies' innovation and competitiveness. Not only can it improve the company's innovation ability and technical level, but it can also enhance the company's market competitiveness, promote the company's sustainable development, and thus improve the company's economic benefits and market value [20]. Innovation is the essence of high-tech enterprise competitiveness, and R&D investment is the primary driving force of enterprise innovation activities. High R&D investment can affect the number of patent applications, innovation, and new product/service development; this has been shown in recent research. According to Paniagua and Rayamajhee [21] in R&D, externality theory played an important role in the relationship, and their study found that the investment of high-tech enterprises in R&D promoted the technological innovation of the enterprise itself, and through the knowledge spillover effect, drove the technological progress of the entire industry. Investments made by those companies such as Google and Apple in R&D, in the fields of artificial intelligence, quantum computing, semiconductor technology, et cetera, also promoted the upgrading of their own products and paved the way for the entire industry with technology.

Moreover, Beiser-McGrath et al. [22] researched the influence of environmental policies on technological innovation and pointed out that investment in R&D is a catalyst for high-tech enterprises to develop green technologies and improve business adaptability to environmental policies [22]. A successful example: Tesla, through massive R&D investment, has achieved efficient battery technology and self-driving systems, leading the new energy vehicle market.

Graafland and Verbruggen [23] also noted that the R&D investment for high-tech enterprises will not only improve the innovation ability of enterprises but also improve the ability to absorb external technical resources [23]. The R&D investment of companies such as Amazon and Microsoft in areas such as cloud computing and artificial intelligence facilitates their integration of external innovation resources and speeds their time to market for more competitive products, for example.

H_2: R&D investment has a positive and significant impact on company performance

2.5. Company Size Has a Positive and Significant Impact on Company Performance

The effect of organisational size on organisational performance is a subject of significant discussion in management and economics. Company size is often regarded as an important variable in very large organizations in each industry, and therefore, enterprises with a larger economic scale can obtain the scale effect, reduce unit costs, and thus enhance their market competitiveness. Generally, big businesses have better market power and brand recognition, which pulls in more customers and businesses towards them. Larger firms often find it easier to access capital and other resources, such as talent, technology, and funding [17]. This section is not about reducing your risk at all, where companies have a greater diversification of resources and revenue streams. Because they have more resources to invest in R and D, larger companies tend to use these resources for product innovation to enhance their performance. Big companies often have better terms in negotiations with suppliers and partners. They can quickly target new markets and scale up quickly, gaining market share. As the scale increases, firms can thus boost operational efficiency through process improvement and a higher level of automation [24]. Also, if a company is large, it can attract and retain skilled workers, which is a vital determinant of company performance. Scale can also serve as an entry barrier that helps companies build and capture a competitive advantage in the market. At the same time, it should be noted that, in some cases, business size is not necessarily positively associated with performance. All these forces may cause scale to become a debilitating factor that makes organizations slow-footed, management less effective, and innovation less hindered. In fact, in the process of pursuing scale expansion, companies also need to focus on internal management, cultural development, and innovation capabilities to ensure that scale growth can be converted into performance improvement [25]. At the same time, the market environment in the high-tech industry is also changing rapidly, and many companies require strong risk resistance capabilities to respond to

challenges such as technological iteration and policy changes. Research has found that larger firms tend to have a higher risk tolerance and a greater capacity to weather market uncertainty.

Scale advantages in high-tech companies and enhanced market adaptability have led to a reduction in the risks of operating through diversification strategies, as evidenced in practice. Take, for example, Alphabet (the parent company of Google), which not only leads the search engine market but also expands into industries such as autonomous driving (Waymo), biotechnology (Verily), and smart home technology (Nest).

According to large corporations, they also have considerable cash flow management capacity and can achieve stable development during economic depression or market volatility [26]. For instance, when a global epidemic swept the world in 2020, this giant was not only able to maintain stable profits; its global market expansion accelerated, and the e-commerce and cloud computing businesses expanded. In high-tech industries, the ability to innovate is a major determinant of corporate performance. Research indicates that large high-tech companies usually have more robust innovation capabilities and can enhance the competitiveness of products and services through R&D investment, technology integration, collaborative innovation, and other methods.

Large enterprises have a larger scale of R&D investment than small and medium-sized enterprises, enabling them to quickly develop new technologies and commercialize them [11]. Microsoft and Google, for example, are financially capable of continuing to invest in the R&D of artificial intelligence and maintaining industry leadership in natural language processing and autonomous driving technology.

There is a view that large organizations do have a better brand image and a more extensive customer base, thus mitigating the negative effects of marketplace changes. Take Apple, for example, which has been firmly sticking to the high-end brand positioning of the smartphone, and the accumulation of a strong user cycle, making its users remain high, and even during the global supply chain breakage, Apple users continue to grow steadily.

H_3: Company size has a positive and significant impact on its performance

2.6. Factors that Affect Business Performance

Factors that affect corporate performance, such as leadership, strategy, innovation, financial health, human resources, organizational culture, etc., have significant effects. Leadership and strategic planning ensure the right direction, innovation drives growth, financial stability ensures operations, human resources enhance execution, and organizational culture enhances cohesion. These factors jointly promote corporate performance improvement by optimizing internal management, enhancing market competitiveness, and improving customer satisfaction.

2.7 Conceptual Framework

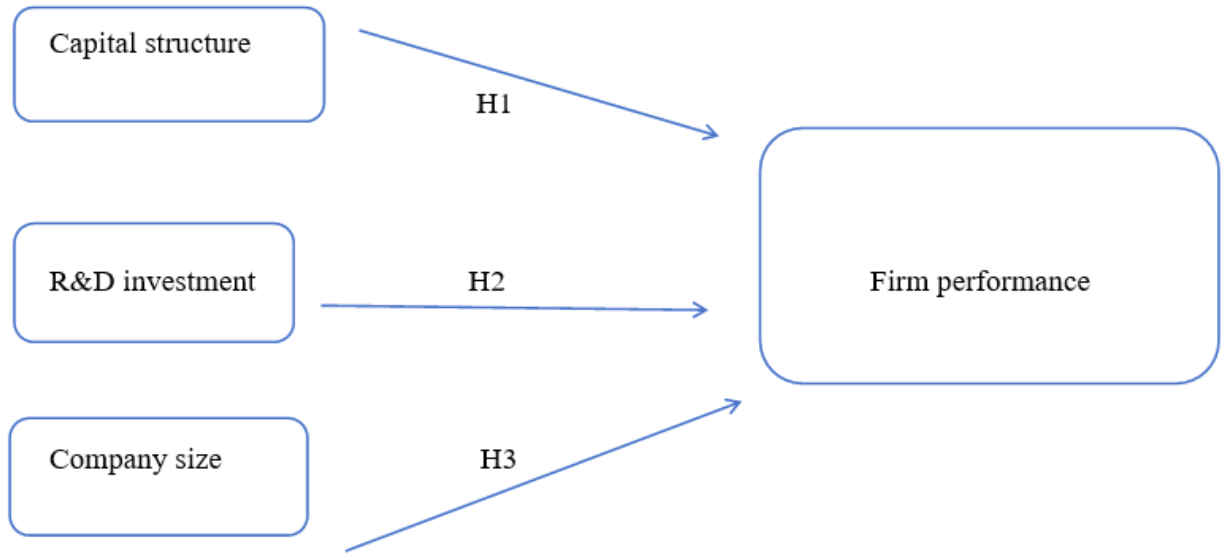

Figure 1.
Conceptual framework illustrating the relationships between capital structure, R&D investment, company size, and firm performance.

2.8. Summary of Hypotheses

H_1: The stability of capital structure has a positive and significant impact on corporate performance

It is assumed that the optimization of capital structure can alleviate capital pressure and reduce capital costs, thereby affecting the company's investment decisions and long-term development.

It is expected that a reasonable capital structure will improve the company's profitability and market competitiveness, while an unreasonable capital structure may have a negative impact on corporate performance due to a high debt ratio.

H_2: R&D investment has a positive and significant impact on corporate performance

It is assumed that R&D investment can significantly enhance the company's innovation ability and competitiveness, improve existing products and services through continuous R&D activities, and support the development of new products and technologies.

It is expected that R&D investment can not only enhance the company's innovation ability and technical level but also improve the company's market competitiveness and promote the company's sustainable development, thereby improving the company's economic benefits and market value.

H_3: Company size has a positive and significant impact on corporate performance

It is assumed that company size is a key factor affecting its competitiveness and market performance. Larger companies can take advantage of economies of scale, reduce unit costs, and enhance market competitiveness.

It is expected that larger companies usually have a stronger market influence and brand awareness and are more likely to obtain capital and other resources, including talent, technology, and funds, thereby improving corporate performance.

These hypotheses will guide empirical analysis to test their relationship with the operating performance of high-tech listed companies. The results will help us understand how different factors affect company performance and provide decision support for company management and policymakers.

By verifying these hypotheses, this study expects to provide new insights into the financial and innovation strategies of the high-tech industry and contribute to the theoretical development of related fields.

3. Research Methodology

This study combines interdisciplinary theories and methods for analysis, mainly using the following two methods:

(1) Empirical research method: Based on the theoretical foundation of economics, accounting, and financial management, this study uses normative analysis methods to define the connotation of return on assets, R&D investment intensity, and long-term debt-to-equity ratio, as well as their relationship with control variables such as company scale, operating income growth rate, and listing years. At the same time, this study employs empirical analysis methods and utilizes a large amount of data extracted from financial statements to construct corresponding empirical models for testing. (2) Quantitative analysis method: In the process of selecting research indicators and building models, this study applies quantitative analysis methods. For example, the intensity of R&D investment can be used to measure the degree of investment in a company's innovation capabilities, and other control variables are used to eliminate interference factors that may affect the return on assets.

3.1. Research Design

This study employs a quantitative research approach to test hypotheses and analyze the impact of capital structure, R&D investment, and firm size on the operating performance of high-tech listed companies.

3.1.1. Data Sampling

The primary objective of this study is to examine the impact of three independent variables: capital structure, R&D investment, and company size on the performance of high-tech companies. To determine the appropriate sample size, all continuous variables were standardized by 1% to mitigate the influence of extreme outliers. Data collation, aggregation, and analysis were conducted using Excel and SPSS 26 software. To ensure the accuracy and reliability of the research results, it is essential to consider additional factors that may influence the dependent variables during empirical analysis. Consequently, this study included the following control variables: company scale, operating income growth rate, and listing years.

These variables are controlled to isolate and identify the true effects of R&D investment intensity and long-term debt-to-asset ratio on company operating performance. Company scale and operating income growth rate may be related to the company's innovation ability and market competitiveness, while listing years may be related to the company's governance structure and market reputation. By controlling these variables, the impact of R&D investment and capital structure on return on assets can be more accurately evaluated, thereby improving the validity of the research conclusions.

3.1.2. Study Procedure

This study uses the CSMAR database to collect valid secondary data, which takes full advantage of the convenience and efficiency of online collection. This data collection will serve as a series of data that will be used by this study to check whether the study agrees or disagrees with relevant variables. Data, such as company capital structure, ratio of R&D investment, company size, etc., will be used and analyzed with rigorous statistical methods to interpret the data effectively. Not only does the data come from the CSMAR database, but it also comes from the official websites of major companies, which are fast, convenient, and have extensive coverage, making them very conducive to large-scale data acquisition. As a result, the collection strategy was selected because it saves time, minimizes supervision, and provides a simplified model of data collection for this study.

3.2. Pilot Study

The main purpose of conducting a pilot test is to determine the validity of any potential questions and data. The validity and reliability of the questions can be determined after the pilot test. A minimum sample size of 10% is required for a pilot test. The sample size is 400, so the first 40 samples will be pilot tested according to the pilot study principles to determine the feasibility of the proposed method to be used in the large-scale survey and to make any necessary adjustments.

3.3. Reliability Test

Reliability testing is employed to assess the feasibility of data collected prior to final predictions, i.e., final data collection. Reliability assessment can be conducted when the dependent variable (DV), independent variable (IV), and

applicable items meet established rules of thumb. Reliability testing analyzes internal consistency, measurement stability, and potential measurement errors by using Cronbach's alpha value and internal consistency tests. This study will utilize Cronbach's alpha to evaluate the reliability and consistency of the data using SPSS. The pilot test demonstrates fair reliability when Cronbach's alpha is between 0.6 and 0.7. An appropriate Cronbach's alpha value ranges from 0.7 to 0.9, with higher values indicating greater reliability. Cronbach's alpha values below 0.7 are considered poor and should not be used in hypothesis testing; such data will be excluded from future analyses.

3.4. Measurement

Method of secondary data collection for this study. Data from relevant listed technology companies were collected through the CSMAR database. Since it is secondary data, no validity test is required. To analyze the data collected, this study will use multiple tests, and appropriate tests will be included to obtain research results.

3.5. Descriptive Statistics

This study will utilize descriptive statistics with frequencies and percentages presented in tables and graphs.

3.5.1. Correlation Analysis

We conducted the correlation analysis for all variables in the study. A correlation analysis method is analyzed using the Pearson correlation coefficient, which demonstrates the strength and direction of linear correlation between variables. The coefficient value lies between -1 and 1, with 1 indicating perfect positive correlation, -1 indicating perfect negative correlation, and 0 indicating no linear correlation.

3.5.2. Multiple Regression Analysis

A multivariate linear regression model is used to analyze the various factors that affect return on assets (ROA). The purpose of the regression model is to determine the impact of independent variables (capital structure, R&D investment, and company size) on the dependent variable (return on assets).

4. Results and Analysis

The following chapter investigates the impact of capital structure and R&D investment on operating performance by using IBM SPSS software. The researcher collected statistical data on the operating performance of high-tech companies in China. Conducting various quantitative tests, the outcome of this study determines the significance and reliability of different financial components and their impact on operating performance. To answer the research questions, test the hypotheses, and draw valid conclusions, this chapter is also very beneficial. A brief discussion is included that helps to summarize all the key findings from the quantitative tests.

4.1. Quantitative Data Analysis

4.1.1. Descriptive Analysis

The descriptive statistical test helps the researcher to determine the central tendency of individual variables. The central tendency of each variable includes mean, median, mode, and standard deviation. Furthermore, the response rate of selected respondents is also understood from the outcome of this table.

Table 2.
Descriptive statistics.

Statistics

		Capital Structure	Research and Development	Company Size	Firm Performance
N	Valid	364	364	364	364
	Missing	0	0	0	0
Mean		3.2243	4003684.2245	5.4810	3352.2665
Median		2.9656	2215961.1500	4.7811	982.0000
Mode		1.13[a]	22070.00[a]	1.10[a]	390.00
Std. Deviation		1.23665	5131745.86823	2.90999	8032.16982

Note: a. Multiple modes exist. The smallest value is shown.

Based on the outcome of Table 2, it has been pointed out that the mean, median, and mode values for Capital Structure are 3.2243, 2.9656, and 1.13. This indicates lower capital structure values, while the overall standard deviation suggests moderate variability. On the other hand, the standard deviation for R&D investment is very high, at 4,003,684.22, indicating strong variation and variability in the dataset. The standard deviation for Company Size is 2.90999, which means a diverse range of firm sizes exists in the dataset. The mean, median, mode, and standard deviation for Firm Performance are quite high, indicating high variability in this research.

4.1.2. Reliability Analysis

The outcome of Table 3 highlights that the value for Cronbach's alpha is 0.740. It has been pointed out by statistical experts that the value for Cronbach's alpha should be between 0.7 and 0.9.

Table 3.
Cronbach Alpha.

Reliability Statistics		
Cronbach's Alpha	**Cronbach's Alpha Based on Standardized Items**	**N of Items**
0.003	0.740	4

Using the Cronbach alpha test, this value becomes greater than 0.7, which means all the selected variables are reliable for this study. Furthermore, the implemented scale is also suitable for measuring the reliability of all items. Hence, this study can generate valid and significant outcomes due to its high reliability.

Table 4.
Item statistics.

Item Statistics			
	Mean	**Std. deviation**	**N**
Capital Structure	3.2243	1.23665	364
Research and Development	4003684.2245	5131745.86823	364
Company Size	5.4810	2.90999	364
Firm Performance	3352.2665	8032.16982	364

As per the outcome of Table 4, it has been determined that the mean and standard deviation values for Capital Structure are 3.2243 and 1.23665. This indicates moderate variation. The mean value for R&D Investment is very high, at 4,003,684.2245, which suggests a high dispersion of this variable in the research. Additionally, the mean and standard deviation values for Firm Performance are also high, indicating that high-tech companies need to invest in these factors to enhance their operating performance.

4.1.3. Factor Analysis

Table 5.
KMO and Bartlett's Test.

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.453
Bartlett's Test of Sphericity	Approx. Chi-Square	681.863
	df	6
	Sig.	0.000

The KMO and Bartlett's value for this study has become 0.453, which is not very high. Therefore, it indicates a moderate correlation in this study. The significant value for Bartlett's Test of Sphericity is 681.863 with a p-value of .000. This suggests that the correlation matrix is not very strong with each other.

Table 6.
Principal Component Analysis.

Total Variance Explained						
	Initial Eigenvalues			**Extraction Sums of Squared Loadings**		
Component	**Total**	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	2.304	57.603	57.603	2.304	57.603	57.603
2	1.111	27.772	85.375	1.111	27.772	85.375
3	0.455	11.383	96.758			
4	0.130	3.242	100.000			

Source: Extraction Method: Principal Component Analysis.

The value for Principal Component Analysis becomes 2.304, and the cumulative value is 57.603. It indicates that the first component can explain 57.603% of the variance. Additionally, the eigenvalues for all four components are greater than 1, which suggests significant variability across all components. The cumulative value for the second component is 85.375, meaning that the first two components together can explain 85.375% of the variance.

4.1.4. Pearson's Correlation Coefficient

The Pearson correlation coefficient test is performed here to determine the correlation between variables. Using the two-tailed significance method, the correlation between variables is assessed at the 0.01 level.

Table 7.
Pearson's correlation coefficient.

Correlations					
		Capital Structure	**Research and Development**	**Company Size**	**Firm Performance**
Capital Structure	Pearson Correlation	1	0.131	0.529	0.131
	Sig. (2-tailed)		0.012	0.000	0.013
	N	364	364	364	364
Research and Development	Pearson Correlation	0.131	1	0.600	0.773
	Sig. (2-tailed)	0.012		0.000	0.000
	N	364	364	364	364
Company Size	Pearson Correlation	0.529	0.600	1	0.335
	Sig. (2-tailed)	0.000	0.000		0.000
	N	364	364	364	364
Firm Performance	Pearson Correlation	0.131	0.773	0.335	1
	Sig. (2-tailed)	0.013	.000	0.000	
	N	364	364	364	364

Note: Correlation is significant at the 0.05 level (2-tailed).
. Correlation is significant at the 0.01 level (2-tailed).

The significance value (sig) between Capital Structure and Firm Performance is 0.131, indicating a weak but positive correlation. This suggests that increased investment in debt may contribute to enhancing a firm's capital structure. The sig value for R&D investment is 0.773, which indicates a moderate correlation with Firm Performance. Therefore, investing in research and development can potentially improve the operational performance of Chinese high-tech companies. The sig value for Company Size is 0.335, also reflecting a moderate correlation with Firm Performance. This implies that Firm Performance is strongly and moderately correlated with other independent variables in this research.

4.1.5. Regression Analysis

The regression analysis helps to identify whether the independent variables have a significant impact on the dependent variable or not. It has been defined by statistical experts that the significance value (sig) should be 0.05 or less to support the variables in this study.

Table 8.
Regression Analysis.

Coefficients								
Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**	**95.0% Confidence Interval for B**	
		B	**Std. Error**	**Beta**			**Lower Bound**	**Upper Bound**
1	(Constant)	-1386.964	720.188		-1.926	0.055	-2803.268	29.340
	Capital Structure	1174.444	249.966	0.181	4.698	0.000	682.866	1666.022
	Research and Development	0.001	0.000	0.947	23.190	0.000	0.001	0.002
	Company Size	-908.661	131.660	-0.329	-6.902	0.000	-1167.580	-649.742

Note: a. Dependent Variable: Firm Performance.

As per the outcome of Table 8, the impact of the independent variable on the dependent variable is understood. It has been pointed out that the significance (sig) value for all three variables is 0.000. This indicates that Capital Structure, R&D Investment, and Company Size have a significant impact on the dependent variable (Firm Performance). It has been defined that if Chinese high-tech companies are able to evaluate or invest more in their capital structure, it supports their firm's operating performance. The Beta coefficient value for this variable is also small, at .181, which refers to a positive impact of capital structure on firm performance.

The significance value (sig) for R&D investment is 0.000, indicating a significant linear relationship with firm performance. In this context, high-tech companies can enhance their firm performance through investment in research and development. The Beta coefficient for R&D investment is 0.947, suggesting it has a stronger impact on firm performance than other predictors. The sig value for the third variable, company size, is also 0.000, denoting a significant relationship with the dependent variable. This implies that increasing organizational size could be beneficial for performance. However, the Beta coefficient for this variable is -0.329, indicating that an increase in company size may negatively influence firm performance.

4.1.6. R-Square

Table 9.
R-square.

Model Summary				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	0.803[a]	0.645	0.642	4804.75909

Note: a. Predictors: (Constant), Company Size, Capital Structure, Research and Development.

The value of R-squared indicates the fitness of the regression model. Generally, the R-square value shows how well the regression model fits the data, and the independent variables can explain the variance within the dataset. A value above 0.5 or 50% is considered appropriate for the study. In this case, the R-square value is 0.645 or 64.5%. This indicates that 64.5% of the variance within the dependent variable can be explained by the independent variables.

4.1.7. ANOVA

Table 10.
ANOVA

ANOVA[a]						
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Regression	15108362417.271	3	5036120805.757	218.149	0.000[b]
	Residual	8310855571.880	360	23085709.922		
	Total	23419217989.151	363			

Note: a. Dependent Variable: Firm Performance.
b. Predictors: (Constant), Company Size, Capital Structure, Research and Development.

The value of F is obtained as 218.149, and the Sig value is 0.000. A high F value indicates that at least one of the independent variables has a significant impact on the dependent variable. The Sig value is also within the threshold of less than or equal to 0.05, which supports this conclusion. Based on this, the null hypothesis is rejected, and the alternative hypothesis is accepted, indicating that the independent variables have a significant impact on firm performance. The ANOVA analysis predicts that the regression model is highly significant in explaining the variations within the dependent variable, firm performance, with the independent variables being company size, capital structure, and R&D investment.

4.1.8. Multicollinearity

Table 11.
VIF.

Model		**Collinearity Statistics**	
		Tolerance	**VIF**
1	(Constant)		
	Capital Structure	0.666	1.503
	Research and Development	0.591	1.691
	Company Size	0.433	2.308

The variance inflation factor analysis is conducted to determine if there is any amount of multicollinearity among the variables or predictors. A high variance among the variables is obtained if the VIF value exceeds 5. However, it can be seen from the table that VIF values are much lower than the threshold. Similarly, it is also observed that the tolerance values are low for all the independent variables. Considering both these values, it can be stated that the multicollinearity among the selected predictors is minimal and does not affect the model.

4.2. Hypothesis Testing

Hypothesis testing is performed to identify whether the assumptions made with the help of the independent and dependent variables for the study are valid. This study analyzes the relationship between capital structure, R&D investment, and company size with firm performance. Data has been collected from official websites regarding the performance of high-tech funds in China [27]. Based on the collected data, a regression analysis has been performed to display the existing relationship between independent and dependent variables.

Table 12.
Hypothesis testing.

Hypotheses	**Results**
H1: The stability of capital structure has a positive and significant impact on corporate performance	Adopted
H2: R&D investment has a positive and significant impact on corporate performance	Adopted
H3: Company size has a positive and significant impact on corporate performance	Adopted

It is evident from the regression analysis that each of the independent variables has a strong relationship with the dependent variable. The Sig values used for determining the relationship between the variables have all been obtained within the necessary threshold. Based on this information, it is concluded that the hypotheses developed for this research have all been accepted. Hence, the assumptions made regarding the research on the impact of factors like capital structure, R&D investment, and company size on the high-tech farm performance in China are proven.

5. Conclusion and Recommendations

5.1. Discussion

The objective of this study was to determine whether capital structure and research and development investment have an impact on the operating performance of listed High-Tech companies in China. The descriptive analysis of the collected data revealed that the impact of R&D investment is much more significant compared to that of company size or the capital structure. However, based on the regression analysis, it is evident that each of the factors has a significant impact on firm performance. The reliability analysis confirmed the accuracy of the data used for the analysis. This demonstrates that the official data employed to interpret the current situation of Chinese firms is authentic and reliable for the study. Various tests have assured the reliability and validity of the data, thereby emphasizing the significance of the relationships between the variables.

The variables in the study have been analyzed through multiple factors and relevant data that are available on published platforms. To interpret the company size, the GDP per capita of high-tech companies in China has been indirectly reflected through their total assets. The capital structure for Chinese high-tech firms has been reflected with the help of labor force development. This indicates the existing funds used for developing the labor force in high-tech firms in China. Finally, to represent the research and development investment and science-related funding made in China, relevant data across multiple years have been considered. The data regarding export performance has been implemented to determine the firm performance of high-tech organizations in China.

The findings of the study are in accordance with the literature discussion that has been made by other authors in the current time. The importance of capital structure has been discussed, highlighting how the most suitable capital structure, according to the market situation, is effective in maximizing performance [28]. This has also highlighted the importance of an appropriate capital structure in developing farm performance, which is in accordance with the research findings. Similarly, Guo and Chen [29] have stated the importance of R&D investment in firm performance development as well. The importance of R&D investment in influencing the acquisition of technical resources and talents for enhancing the company's reserves is necessary for developing the competitiveness of a business. This can contribute to the continuous development of product design that ultimately allows the organization to meet market demand.

Beiser-McGrath et al. [22] have highlighted in their literature finding that high-tech companies can use the scalability of their company to enhance market adaptability and reduce the risk of operations. Implementing diversification strategies has been adopted by many large companies in the high-tech industry to overcome challenges and improve the firm's performance. Thus, it is observed that the literature findings by various authors support the data analysis conducted for the available official data on high-tech firms.

5.2. Key Findings

5.2.1. Capital Structure has a Certain Impact on Firm Performance

The significance value between Capital Structure and Firm Performance is 0.131, indicating a weak but positive correlation. This suggests that increased investment in debt can potentially enhance a firm's capital structure. By balancing debt and equity financing, companies can reduce financing costs and financial risks, thereby optimizing profitability. The regression analysis shows a positive relationship between capital structure stability and returns on assets (ROA), consistent with the Dynamic Trade-Off Theory [8]. For example, firms with moderate leverage ratios (e.g., 40–60% debt-to-equity) tend to have higher ROA compared to over-leveraged peers, as excessive debt increases bankruptcy risks while insufficient debt limits tax shield benefits.

5.2.2. R&D Investment Drives Innovation and Market Competitiveness

R&D investment emerges as the most influential factor, with a standardized Beta coefficient of 0.947 in the regression model. This underscores its critical role in fostering innovation, product development, and market adaptability. High-tech companies with R&D intensity (RDI) exceeding 5% of operating income exhibit stronger revenue growth and market share expansion, as seen in firms like Huawei and Tencent. The findings align with Endogenous Growth Theory, emphasizing innovation as a core driver of long-term competitiveness [30].

5.2.3. Company Size Yields Mixed Effects

While larger companies benefit from economies of scale and resource accessibility, the study identifies a negative Beta coefficient (-0.329) for company size. This suggests that excessive scale may lead to inefficiencies, such as bureaucratic delays and reduced agility. For example, firms with assets exceeding $10 billion face diminishing returns due to operational complexity, whereas mid-sized companies (assets $1–5 billion) achieve optimal performance by balancing scale and flexibility.

5.3. Limitations of the Study

While this study provides valuable insights into the impact of capital structure and R&D investment on the operating performance of high-tech companies, it is not without limitations. Firstly, the study is confined to the listed high-tech companies in China, which may limit the generalizability of the findings to other regions or industries. Future research could explore the applicability of these findings in different geographical and industrial contexts. Secondly, the data used spans from 2018 to 2022, which may not capture the most recent market shifts and regulatory changes. Extending the data range could provide a more comprehensive view. Lastly, while the study controls several variables, other unobserved external factors may influence the results. Further research could incorporate additional control variables to enhance the robustness of the analysis. Despite these limitations, the study offers actionable insights for high-tech companies seeking to optimize their financial and innovative strategies.

5.4. Contribution of the Study

This study makes several significant contributions to the existing body of literature and practice in the field of corporate finance and innovation management. Firstly, it provides a comprehensive empirical analysis of how capital structure and R&D investment influence the operating performance of high-tech companies. By focusing on listed companies in China, this research offers region-specific insights that are valuable for both academic and practical purposes.

Secondly, the study integrates multiple theoretical frameworks, including the Modigliani-Miller Theorem, Dynamic Trade-Off Theory, and Economies of Scale Theory, to provide a robust theoretical foundation for understanding the complex relationships between financial strategy, innovation, and firm performance. This integration of theories offers a more holistic view of the factors influencing high-tech firms' performance.

Thirdly, the research highlights the importance of R&D investment as a key driver of innovation and competitiveness in the high-tech industry. The findings emphasize the need for continuous investment in R&D to enhance product quality, market adaptability, and long-term sustainability. This insight is particularly relevant for high-tech companies aiming to maintain a competitive edge in rapidly evolving markets.

Finally, the study provides practical guidance for corporate executives and policymakers. It suggests that optimizing capital structure, investing in R&D, and leveraging the advantages of company size can significantly enhance the operating performance of high-tech companies. These findings can inform strategic decision-making and policy formulation aimed at fostering innovation and sustainable growth in the high-tech sector.

In summary, this study contributes to the literature by providing empirical evidence on the impact of capital structure and R&D investment on firm performance, integrating multiple theoretical perspectives, and offering actionable insights for practitioners and policymakers. Future research can build on these findings to explore industry-specific dynamics, moderating factors, and long-term effects in different contexts.

5.5. Suggestion for Future Research

Future research can build on the findings of this study by exploring several promising avenues. Firstly, extending the scope to include high-tech companies from other regions or industries would enhance the generalizability of the results. This could provide insights into how regional differences and industry-specific factors influence the relationship between capital structure, R&D investment, and firm performance.

Secondly, incorporating a longer time span or more recent data would capture the impact of emerging technologies and market shifts. This could offer a more dynamic understanding of how firms adapt their strategies over time.

Thirdly, examining the role of external factors such as economic cycles, regulatory changes, and technological disruptions could reveal how these variables moderate the effects of capital structure and R&D investment on performance.

Finally, future studies could explore the impact of different types of R&D investments, such as basic research versus applied development, and how they differentially affect firm performance. Additionally, investigating the role of corporate governance and leadership in shaping these relationships could provide further insights into strategic decision-making.

By addressing these areas, future research can contribute to a more comprehensive understanding of the factors driving high-tech firms' performance in a rapidly evolving global landscape.

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