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R&D Investment on Chinese New Energy Vehicle Enterprises: A Development of Financial Performance Test Model

Yanqin Yin

Adamson University, Manila,1000, Philippines

Abstract: This study focuses on Chinese new energy vehicle listed companies, aiming to explore the effect of R&D investment on corporate financial performance and develop a financial performance testing model. The study used panel data from 2013 to 2023 and employed descriptive statistics, correlation analysis, and regression analysis to systematically analyze the relationship between R&D investment, R&D output, and financial performance.The research reveals that: (1) R&D investment significantly positively correlates with corporate financial performance, suggesting that an increase in R&D investment can significantly boost a company's financial performance; (2) R&D investment significantly boosts R&D output, leading to more innovative achievements; and (3) R&D output partially mediates the relationship between R&D investment and financial performance, suggesting that an increase in R&D output enhances corporate financial performance. The research results emphasize the crucial role of R&D investment in improving corporate financial performance and suggest that companies should attach importance to R&D investment, optimize R&D resource allocation, strengthen R&D project management, and build a corporate culture that supports innovation. Simultaneously, the government should implement incentive measures to stimulate enterprises' investment in research and development, thereby fostering technological innovation and industrial upgrading.

Keywords: R&D investment, R&D output, Financial performance, New energy vehicles, Chinese listed companies.

1. Introduction

1.1. Background of the Study

Financial performance refers to the results of a company in finance, reflecting its economic benefits and financial health. Financial performance is an important reference for corporate investment decisions. Excellent financial performance can enhance the reputation and credibility of a company, boost the confidence of investors and financiers, and provide more financial support and resource assurance for the company's research and development investment.

There is a certain connection between R&D investment and financial performance. In the long-term development of firms, firms should balance R&D investment and financial performance at different stages of development to ensure continuous improvement in the company's technological level and product innovation capability. Cai Y.'s (2022) research reveals a negative correlation between R&D investment and short-term financial performance in manufacturing companies, but a positive correlation with long-term financial performance. Wang Z. (2022) figured that to make R&D investment positively effective, it must exceed the minimum amount of R&D investment. The effective lag period for determining R&D investment is two years. By ensuring that the intensity of R&D investment reaches the minimum threshold within 3 years, companies can ensure that R&D investment is positive, which can effectively promote corporate financial performance.

With increasing concerns about environmental protection and sustainable development, many countries are taking various measures to promote the development and popularization of new energy vehicles. Based on energy conservation and emission reduction policy goals, the Chinese government has proposed a series of policy supports. Research by Xiao X (2022) found that government subsidies can effectively promote new energy vehicle companies to increase R&D investment, thereby improving the firm's financial performance. This measure has led to the continuous expansion of the Chinese new energy vehicle industry and an annual increase in market share. However, after the cancellation of government support policies, Chinese new energy vehicles still face a series of problems and challenges in development, such as technological bottlenecks, high costs, and the construction of charging infrastructure. Innovative investment, technological output, and financial performance significantly influence these problems and challenges.

This study employs Chinese listed new energy vehicle companies as research subjects, gathers pertinent data, and develops a financial performance test model that examines R&D investment, R&D output, and financial performance. Companies can maintain their competitiveness in fierce market competition by identifying a balanced ratio between R&D investment and technological output, optimizing resource allocation, and improving corporate financial performance.

1.2. Hypotheses

Currently, scholars both domestically and internationally have conducted research on different regions and industries, and their findings suggest that R&D investment can drive financial performance improvement (Hao J.L., 2019; Liu Y., 2020). However, after reaching a certain level, the financial performance of enterprises tends to decline, exhibiting an inverted "U" shape (Song J., 2023). Additionally, there is a lag effect of R&D investment on financial performance, with short-term R&D investment having a negative effect (Lei Z.H., 2022; Lin J., 2023), while long-term R&D investment has a positive effect (Wang X., 2023). Based on the aforementioned evidence, this study formulates $H_0 1$ as follows:

$H_0$1: The R&D investment of Chinese listed new energy vehicle enterprises has no significant effect on financial performance.

R&D investment can effectively promote R&D output (Wang K., 2020; Yuan R., 2020; Yuan S., 2020; Fan X., 2021; Zhou Z., 2021; Li B., 2023; Xue R., 2023), resulting in a series of new materials, devices, processes, and patents. However, there is not a linear relationship between R&D investment and output; they do not increase or decrease proportionally. Therefore, excessive R&D investment can have a negative effect on R&D output (Zhou J.Y., 2022; Chen X., 2023). Financial resources constrain R&D investment, leading to uncertain R&D output, which subsequently impacts corporate financial performance (Ye M., 2022; Zhang Q., 2023). Therefore, this study formulates $H_0$2 and $H_0$3 based on the above evidence.

$H_0$2: The R&D investment of Chinese listed new energy vehicle enterprises has no significant effect on R&D output.

$H_0$3: The R&D investment of Chinese listed new energy vehicle enterprises has no significant effect on financial performance through R&D output.

1.3. Conceptual Framework

This study focuses on the effect of R&D investment on the financial performance of Chinese-listed new energy vehicle companies. This study created the Financial Performance Test Model, a regression model, to examine the potential significant relationship between R&D investment and financial performance. It uses R&D investment as the independent variable, financial performance as the dependent variable, and R&D output as the intermediate variable.

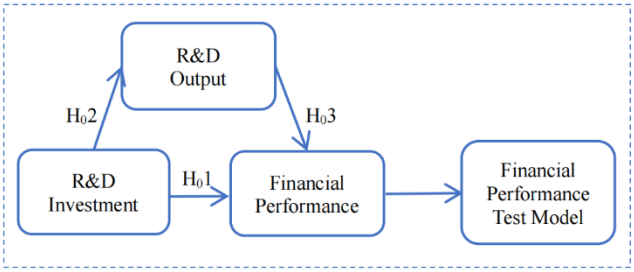

Figure 1. Conceptual Framework

The R&D investment and output of a company affect its financial performance, core competitiveness, and technological innovation. A company's research and development capabilities not only affect new technologies but also help the company maintain a competitive advantage.

In the field of new energy vehicles, there is fierce market competition and rapid technological updates. Therefore, new energy vehicle companies will conduct research on R&D investment, R&D output, and financial performance, which will help companies increase R&D output, enhance R&D innovation capabilities, enhance their profitability, and maintain their core competitiveness in fierce market competition.

2. Methods

2.1. Data According to Source

The research sample for this study includes A-share listed companies in the new energy vehicle sector on the Shanghai and Shenzhen stock exchanges, certified by the Chinese government from 2013 to 2023.

Firstly, all data used in this study is secondary data sourced from publicly available databases in China, such as the WIND database, the CNRDS database, the CSMAR database, and the Qianzhan database.This study emphasize that researchers adhere to relevant privacy protection and intellectual property laws and regulations, and collect data through legal means.

Secondly, in the A-share markets of Shanghai and Shenzhen, companies marked as ST, ST*, and PT typically indicate specific financial or operational difficulties. Therefore, this study excludes these companies.

Additionally, the time span of this study is from 2013 to 2023. To ensure data reliability and completeness, this study also exclude any incomplete data for any company during this period.

Finally, based on the above criteria, this study has identified 62 companies that meet the requirements. This study will utilize Excel 2013 for data organization and Stata 17.0 software for data processing and empirical testing.

2.2. Data According to Method

This study will employ empirical research, keeping in mind the theme of this study. Hence, this section presents numerical data. The numerical data in this section refer to the relevant variables involved in this study. Here's the specific variable information:

1) Independence Variable

The independent variable of this study is R&D investment, primarily measured by the R&D capital investment intensity and R&D manpower investment intensity.

R&D capital investment intensity refers to the proportion of R&D output to business revenue during the R&D process; it serves as a measure of R&D capital intensity.

Also, because major databases don't have enough information on the number and percentage of R&D workers to meet the needs of this research, the proportion of technicians to total employees is used as a stand-in for the intensity of R&D worker investment in this study.

2) Mediating Variable

The mediating variable of this study is R&D output, primarily measured by the number of patents and the net value of intangible assets.

The number of patents most directly reflects the output of innovation in a company's R&D activities, thereby illustrating the relationship between R&D investment and output. Since the number of patents is quantifiable and directly represents a company's R&D achievements, it can serve as a measure of R&D output (Griliches, 1990; Lev, 1999; Seru, 2014). However, this study uses the annual increase in patents as the R&D increment, highlighting the yearly output and efficiency of a company's R&D efforts.

They consider intangible assets as a variable that represents the effectiveness of R&D output, drawing on the work of Fortune and Shelton in 2012. While the quantity of patents can more directly reflect innovation output, capturing firms' long-term accumulation and absorptive capacity for knowledge and technology can be challenging, as noted by Aldieri in 2018. Consequently, the measurement effect of intangible asset stock is more effective in this context. Therefore, this study uses the net value of intangible assets as a measure of R&D output.

3) Dependence Variable

The financial performance can reflect both the long-term performance and future cash flow earnings information.

In this study, the dependent variable is the financial performance of enterprises, primarily measured by return on

investment (ROI), return on invested capital (ROIC), return on equity (ROE-Dupont), and return on assets (ROA).

Return on Investment (ROI) is assessing the rate of return on investment in specific projects or assets. This study can use ROI to evaluate the return on investment in R&D of new energy vehicles, specifically the profit growth resulting from R&D output.

Companies use all capital, including shareholder equity and debt, to obtain a return, known as the return on invested capital (ROIC). In the context of new energy vehicle enterprises, ROIC can evaluate how effectively companies utilize capital for R&D output to achieve higher profit margins.

Return on assets (ROA) represents the ratio of earnings achieved by an enterprise during a specific period to its total assets for that period. It is a core indicator reflecting the comprehensive utilization of assets by the enterprise and is an important measure of its profitability, effectively capturing the historical performance of the enterprise. Decision-makers can use it for investment decision-making and risk assessment.

Companies use return on equity (ROE-Dupont) to measure the return on their shareholder investments. In the context of new energy vehicle companies, ROE-Dupont can help assess how enterprises utilize shareholder equity for R&D output and translate it into shareholder value growth.

Therefore, this study selects ROI, ROIC, ROA, and ROE-Dupont as indicators representing the financial performance of enterprises, respectively, to serve as the dependent variables in the study model.

2.3. Sample selection and data sources

This study selected 62 Chinese new energy vehicle listed firms between 2013 and 2023 as research subjects, yielding a total of 617 valid data points.

For data preparation and statistical analysis, this study used a spreadsheet and Stata 17.0 software, and it truncated all continuous variables by 1% to reduce the influence of extremists on the empirical results.

2.4. Statistical Treatment

Statistical treatment refers to the process of analyzing and handling research data using statistical methods.

Based on the SOP, this study will select appropriate statistical techniques or models to interpret data, test research hypotheses, reveal relationships between variables, and validate the reliability and significance of research results.

This study used simple linear regression for SOP 1 to test the correlation in RDr, RDh, ROA, ROE, ROI, and ROIC. This study used simple linear regression for SOP 2 to examine the correlation in RDr, RDh, Patent, and NIA. For SOP 3, this study focused on the mediating effect and used regression to determine the correlation between RDr, RDh, ROA, ROE, ROI, ROIC, Patent, and NIA. This study collated the regression highlights from SOP1 to SOP3, revealed the relationship between each variable, and proposed a financial performance test model.

3. Results

This study presents the regressions one by one in chapter 3, analyzing them in accordance with the order in which chapter 1 describes the problem statement. Chapter 3 employs quantitative analysis to reveal research findings.

3.1. The R&D Investment of Chinese Listed NEV Enterprises Has Significant Effect on Financial Performance

3.1.1. Descriptive Statistics on R&D Investment and Financial Performance

Table 1. Descriptive Statistics on R&D Investment and Financial Performance

Variable	Obs	Mean	SD	Min	Max	Interpretation
ROI	617	0.069	0.087	-0.133	0.268	Positive
ROIC	617	0.070	0.107	-0.177	0.327	Positive
ROA	617	0.051	0.067	-0.123	0.211	Positive
ROE	617	0.090	0.163	-0.288	0.478	Positive
RDr	617	0.048	0.025	0.000	0.109	Positive
RDh	617	0.182	0.093	0.000	0.410	Positive

Table 1, which displays data from descriptive statistics analysis, shows that the mean of RDr and RDh is 0.048 and 0.182, respectively, indicating a relatively stable investment by companies in R&D. This investment reflects the continuous attention and resource allocation of enterprises in innovation and technology. At the same time, the financial performance indicators (ROI, ROIC, ROA, ROE) were all positive (0.069, 0.070, 0.051, and 0.090, respectively). These positive mean values show that the enterprises get a satisfactory financial return while they invest in R&D. This positive financial performance may benefit from new product development, technological improvements, and increased market competitiveness resulting from R&D investment.

The sixth value is the maximum value. It's straightforward to determine that the highest values of the financial performance indicators (ROI, ROIC, ROA, and ROE) are 0.268, 0.327, 0.211, and 0.478, respectively. This indicates that some enterprises achieve exceptionally high financial returns after investing in R&D. In particular, the maximum ROE of 0.478 indicates that some enterprises have achieved significant success in their R&D investments, with financial return being the primary objective. objective. The maximum value of the R&D Investment Index (RDr = 0.109, RDh = 0.410) also indicates that some enterprises invest a lot of resources in R&D. Such high R&D investment often means higher innovation ability and larger market share, which further promotes the financial performance of enterprises. These findings are consistent with prior research that underscores the variability in R&D investments and their effect on financial performance (Chen et al., 2020).

This study will talk more about the impact of R&D investment on financial performance below.

3.1.2. Correlation Analysis on R&D Investment and Financial Performance

A statistical method known as the Pearson test measures the linear correlation between two variables. Pearson determines

whether a linear relationship exists between the two variables, as well as the strength and direction of that relationship.

Therefore, Table 2 illustrates the use of the Pearson test to examine the correlation among various variables.

Table 2. Correlation Analysis on R&D Investment and Financial Performance

Correlation between variable		Pearson correlated coefficient	Interpretation
RDr	ROI	0.400***	Significant
RDh		0.426***	Significant
RDr	ROIC	0.357***	Significant
RDh		0.354***	Significant
RDr	ROA	0.382***	Significant
RDh		0.422***	Significant
RDr	ROE	0.352***	Significant
RDh		0.401***	Significant
* * * indicates significant at the 1% level * * indicates significant at the 5% level * indicates significant at the 10% level			

The Pearson correlated coefficient is one of the evaluated factors in Table 2, covering variables such as ROI, ROIC, ROA, ROE, RDr, and RDh. The correlation coefficients indicate a significant correlation in RD, RDh, ROI, ROIC, ROA, and ROE, with most of these correlations being significant at the 1% level (marked as ***). For example, the correlation coefficient between RDr and ROI is 0.400, between RDr and ROE is 0.352, and between RDh and ROI is 0.426. These results show that R&D investment influences a firm's financial performance, suggesting that increasing R&D investment enhances the company's profitability. The work of Liu and Atuahene-Gima (2023), who found a similar relationship between RDr, ROA, and ROE, also supports this positive correlation.

3.1.3. Multicollinearity Test on R&D Investment and Financial Performance

It's normal to adopt a multicollinearity test to evaluate model efficiency. One important metric for assessing multicollinearity is VIF. Table 3 displays the test results using R&D investment (RDr and RDh) as the independent variable.

Table 3. Multicollinearity Test on R&D Investment and Financial Performance

Variable	VIF	1/VIF
Lev	1.44	0.693716
TQ	1.32	0.757234
ListAge	1.22	0.819914
Loss	1.18	0.849678
Cash	1.16	0.862691
Growth	1.14	0.880773
RDr	1.10	0.910865
RDh	1.09	0.918331
Dual	1.08	0.925837
Top5	1.08	0.926371
Indep	1.06	0.941706
Big4	1.03	0.972324
Mean VIF	1.16	

VIF measures how significantly different variables affect each other. Multicollinearity between variables may not pose a problem if the tolerance exceeds 0.1 and if the VIF value is between 0 and 10.

The key findings in multicollinearity indicate that all variables have VIF values within 10, and the tolerance is above 0.1. This indicates that there is no multicollinearity among the variables in this model. Qian, Y (2021) also emphasized the importance of multicollinearity in regression analysis, stating that the absence of it ensures an accurate estimation of each variable's effect on financial performance.

3.1.4. Model Validation on R&D Investment and Financial Performance

When the statistical findings under the null hypothesis follow an F distribution, the test is known as an F-test. This study often uses it to evaluate statistical models that employ multiple parameters, determining whether all or some of these are suitable for population estimation. This study used an F-test to determine the use of fixed effects models.

When the F-test's P-value is less than 0.05, a fixed effects model is appropriate for estimating how RDr and RDh affect financial performance.

The F-test revealed a P-value of less than 0.05, leading to the construction of a fixed effects model in this study. Zhao et al. (2021) use similar methods and share the same finding that RDr and RDh affect financial performance.

3.1.5. Regression Results on R&D Investment and Financial Performance

Table 4 displays the regression results of R&D capital investment intensity (RDr) and R&D investment manpower intensity (RDh) on corporate financial performance, including ROI, ROIC, ROA, and ROE.

As shown in table 4, the P value of R&D investment on the financial performance of enterprises is less than 1%, which is significantly positive. It demonstrates how raising RDr and RDh may help the company's ROI, ROIC, ROA, and ROE significantly improve.

The regression coefficients of RDr for ROI, ROIC, ROA, and ROE were 1.360, 1.484, 1.018, and 2.222. The regression coefficients of RDh for ROI, ROIC, ROA, and ROE were 0.389, 0.397, 0.300, and 0.691, respectively. The regression coefficients reveal that the increase in R&D investment has significantly increased the return on investment. R&D investment significantly impacts the financial performance of enterprises. In this case, RDr and RDh positively affect ROI, ROIC, ROA, and ROE.

R^2 is a valid illustration of each model's capacity for clarification. In other words, the stronger the model's explanatory capacity, the greater the R^2. From model 1 to model 8, model 2's R^2 is 0.239, which is higher than that of other models, and model 2 is the best model in SOP 1. RDh strongly affects ROI, as demonstrated.

In summary, this result refutes hypothesis $H_0$1, suggesting that R&D investment positively impacts the financial performance of enterprises. This could be the case since R&D expenditures boost the company's potential for innovation and competitiveness in the market, which raises profits.

Innovative activity significantly impacts corporate financial performance, according to previous findings. Smith and Li (2020) provided evidence of this relationship in their research on the automotive industry. They found that increased R&D investment has a significant impact on improved ROE for public companies in the automotive industry. Chen and Zhao (2022) further confirmed that RDr has a significant impact on enterprises' ROA improvement. This aligns with the findings of the study.

Table 4. Regression Results on R&D Investment and Financial Performance

DV	Model	IV	Coefficients	t	P>|t|	R^2	Remark
ROI	1	Cons-	0.043	0.66	0.508	0.225	Reject $H_0$1
		RDr	1.360	10.27	0.000		
	2	Cons-	-0.006	-0.09	0.926	0.239	
		RDh	0.389	10.87	0.000		
ROIC	3	Cons-	0.032	0.39	0.698	0.193	
		RDr	1.484	8.96	0.000		
	4	Cons-	-0.017	-0.21	0.837	0.189	
		RDh	0.397	8.78	0.000		
ROA	5	Cons-	-0.025	-0.50	0.615	0.198	
		RDr	1.018	9.87	0.000		
	6	Cons-	-0.064	-1.27	0.203	0.221	
		RDh	0.300	10.83	0.000		
ROE	7	Cons-	-0.119	-0.95	0.341	0.187	
		RDr	2.222	8.75	0.000		
	8	Cons-	-0.209	-1.70	0.089	0.218	
		RDh	0.691	10.17	0.000		
DV mean Dependence Variable; IV mean Independence Variable							

3.2. The R&D Investment of Chinese Listed NEV Enterprises Has Significant Effect on R&D Output

3.2.1. Descriptive Statistics on R&D Investment and R&D Output

When conducting descriptive statistical analysis on RDr, RDh, patents, and NIA in Chinese NEV companies, this study observed two key indicators in table 6: patents and NIA.

Table 5's data reveals that both indicators have observed values of 617, which suggests a large sample size and excellent representativeness of the results. The mean values of patents and NIA are 4.676 and 20.114. However, 1.457 is the SD value; the fluctuation of net intangible assets is relatively small, which means that the intangible asset data of enterprises is relatively concentrated and does not very much.

Table 5. Descriptive Statistics on R&D Investment and Financial Performance

Variable	Obs	Mean	SD	Min	Max	Interpretation
Patent	617	4.676	1.622	0.000	7.971	Positive
NIA	617	20.114	1.457	16.816	23.563	Positive

Table 5 shows some fluctuations in the number of patents and intangible assets for enterprises, but the overall trend is positive, indicating that innovative activity impacts the innovation achievements (patents) and net intangible assets (NIA) of enterprises.

This variability underscores the heterogeneity in innovation capabilities across firms, aligning with findings from prior research that emphasize the diversity in R&D outcomes (Lei et al., 2022).

This study will discuss the relevance of analysis in more detail below.

3.2.2. Correlation Analysis on R&D Investment and R&D Output

The correlation analysis in RDr, RDh, Patent, and NIA clearly shows that RDr and RDh have a significant impact on Patent and NIA in Table 6.

Table 6. Correlation Analysis on R&D Investment and and R&D Output

Correlation between variable		Pearson correlated coefficient	Interpretation
RDr	Patent	0.358***	Significant
RDh		0.363***	Significant
RDr	NIA	0.339***	Significant
RDh		0.395***	Significant
* * * indicates significant at the 1% level * * indicates significant at the 5% level * indicates significant at the 10% level			

The Pearson correlated coefficient is one of the evaluated factors in Table 6, covering variables such as RDr, RDh, patents, and NIA. This study confirms what other research has found: that investing in R&D leads to more innovation (Chen et al., 2023) by showing that there is a strong link between RD, RDh, patents, and NIA. Most of these links are significant at the 1% level (marked as ***).

3.2.3. Multicollinearity Test on R&D Investment and R&D Output

Table 7. Multicollinearity Test on R&D Investment and R&D Output

Variable	VIF	1/VIF
Lev	1.44	0.693716
TQ	1.32	0.757234
ListAge	1.22	0.819914
Loss	1.18	0.849678
Cash	1.16	0.862691
Growth	1.14	0.880773
RDr	1.10	0.910865
RDh	1.09	0.918331
Dual	1.08	0.925837
Top5	1.08	0.926371
Indep	1.06	0.941706
Big4	1.03	0.972324
Mean VIF	1.16	

It is crucial to detect potential multicollinearity issues before conducting regression analysis. In this study, the largest Variance Inflation Factor (VIF) is 1.44, with each VIF

being significantly lower than 10. In this case, the multicollinearity of SOP 2 does not pose any issues.

Specifically, the VIF value ranges between 1.03 and 1.44, far below the general warning line of 8, indicating that all variables are suitable for subsequent regression analysis.

This finding is crucial for the regression analysis, as it ensures that each independent variable can be accurately assessed for its unique impact on the dependent variables, consistent with the methodological rigor emphasized in the statistical literature (Qian, Y., 2021).

3.2.4. Model Validation on R&D Investment and R&D Output

The results of the previously conducted F-test will guide the construction of a fixed effects model.

3.2.5. Regression Results on R&D Investment and R&D Output

Table 8 contains the answer to SOP 2.

As shown in table 8, the P values of RDr, RDh, Patent, and NIA are less than 1%, which is significantly positive. The coefficients of RDr for Patent and NIA are 23.583 and 17.881, respectively. The regression coefficients of RDh for Patent and NIA were 6.281 and 5.457, respectively. This indicates a significant influence of RDr and RDh on patents and NIAs.

R^2 is a valid illustration of each model's capacity for clarification. In other words, the stronger the model's explanatory capacity, the greater the R^2. From Model 9 to Model 12, Model 12's R^2 is 0.255, surpassing that of the other models, making it the most effective model in SOP 2. The strong influence of RDh on NIA is evident.

The above findings refute hypothesis $H_0$2, suggesting a positive influence of R&D investment on the R&D output of enterprises. In summary, R&D investment significantly increases the innovation output of enterprises, which may be because more R&D resources can attract more outstanding R&D talents and promote the accumulation of knowledge and technological innovation.

Atuahene-Gima (2023) confirmed through meta-analysis that R&D investment positively influences innovation performance. Liu's (2023) research covers multiple industries, providing a broader context for the findings of this study.

Table 8. Regression Results on R&D Investment and R&D Output

DV	Model	IV	Coefficients	t	P>|t|	R^2	Remark
ROI	9	Cons-	4.317	3.45	0.001	0.170	Reject $H_0$2
		RDr	23.583	9.25	0.000		
	10	Cons-	3.556	2.82	0.005	0.164	
		RDh	6.281	9.00	0.000		
ROIC	11	Cons-	17.588	16.29	0.000	0.233	
		RDr	17.881	8.12	0.000		
	12	Cons-	16.881	15.79	0.000	0.255	
		RDh	5.457	9.21	0.000		
		RDh	4.317	3.45	0.001		
DV mean Dependence Variable IV mean Independence Variable							

3.3. The R&D Investment of Chinese Listed NEV Enterprises Has Significant Effect on Financial Performance through R&D Output.

3.3.1. Descriptive Statistics on R&D Investment and Financial Performance through R&D Output

Table 9 shows a descriptive statistical analysis of how much money Chinese companies that make new energy vehicles spend on research and development (RDr and RDh), how much they produce (patents and NIA), and how well they do financially (ROI, ROIC, ROA, and ROE).

The descriptive statistics in the table show that RDr and RDh significantly affect ROI, ROIC, ROA, and ROE. The mean value in R&D investment is 4.8% (RDr) and 18.2% (RDh), respectively, indicating that enterprises have a certain amount of resource investment in R&D. Despite the sample's negative values for financial performance indicators such as ROI, ROIC, ROA, and ROE, which suggest underperformance in some companies, RDr and RDh clearly contribute positively to patents and intangible assets (NIA), and their correlation with financial performance is positive.

Table 9. Descriptive Statistics on R&D Investment and Financial Performance through R&D Output

Variable	Obs	Mean	SD	Min	Max	Interpretation
ROI	617	0.069	0.087	-0.133	0.268	Positive
ROIC	617	0.070	0.107	-0.177	0.327	Positive
ROA	617	0.051	0.067	-0.123	0.211	Positive
ROE	617	0.090	0.163	-0.288	0.478	Positive
RDr	617	0.048	0.025	0.000	0.109	Positive
RDh	617	0.182	0.093	0.000	0.410	Positive
Patent	617	4.676	1.622	0.000	7.971	Positive
NIA	617	20.114	1.457	16.816	23.563	Positive

These findings are consistent with prior research that emphasizes the variability in financial performance and R&D investment in the automotive industry (Smith & Li, 2020).

This study will discuss the relevance of RDr, RDh, patents, and NIA in ROI, ROIC, ROA, and ROE in more detail below.

3.3.2. Correlation Analysis on R&D Investment and Financial Performance through R&D Output

Table 10 presents the correlation analysis in RDr, RDh,

patents, NIA, and financial performance. The symbol *** denotes the statistically significant value, which is 1%. The significant positive impact of RDr and RDh on patents and NIAs is evident in all financial performance indicators.

Table 10. Correlation Analysis on R&D Investment and Financial Performance through R&D Output

Correlation between variable		Pearson correlated coefficient	Interpretation
RDr	ROI	0.400***	Significant
RDh		0.426***	Significant
Patent		0.369***	Significant
NIA		0.357***	Significant
RDr	ROIC	0.357***	Significant
RDh		0.354***	Significant
Patent		0.337***	Significant
NIA		0.365***	Significant
RDr	ROA	0.382***	Significant
RDh		0.422***	Significant
Patent		0.392***	Significant
NIA		0.392***	Significant
RDr	ROE	0.352***	Significant
RDh		0.401***	Significant
Patent		0.400***	Significant
NIA		0.407***	Significant
* * * indicates significant at the 1% level * * indicates significant at the 5% level * indicates significant at the 10% level			

These results align with previous studies that have established a positive relationship between R&D investment, R&D output, and financial performance (Chen & Zhao, 2022).

3.3.3. Multicollinearity Test on R&D Investment and Financial Performance through R&D Output

Table 11 provides a multicollinearity test for RDr, RDh, Patent, NIA, TQ, and so on. The largest VIF is 1.44, significantly less than 10. There is no issue of multicollinearity in SOP 3. This provides a guarantee for conducting robust regression analysis, ensuring the independence and stability of each variable in the model.

Table 11. Descriptive Statistics on R&D Investment and Financial Performance through R&D Output

Variable	VIF	1/VIF
Lev	1.44	0.693319
TQ	1.33	0.754247
ListAge	1.3	0.769742
Loss	1.35	0.738607
Cash	1.29	0.777118
Growth	1.28	0.781357
RDr	1.22	0.819085
RDh	1.18	0.84762
Dual	1.16	0.862079
Top5	1.14	0.879926
Indep	1.08	0.925405
Big4	1.08	0.925563
Mean VIF	1.21	

This finding is crucial for the validity of the regression models used in this study, echoing the methodological rigor emphasized in the statistical literature (Qian, Y., 2021).

3.3.4. Model Validation on R&D Investment and Financial Performance through R&D Output

Based on the results of the F-test conducted previously, it has been determined that a fixed effects model will be constructed.

3.3.5. Regression Results on R&D Investment and Financial Performance through R&D Output

This section aims to investigate the mediating role of patents and NIA. Combining this case with the regression results in Tables 4, 8, and 12, this study finds that R&D investment significantly influences the financial performance of enterprises through a significant impact on R&D output. R&D output partially mediates the impact of R&D investment on enterprises' financial performance. This result rejects hypothesis $H_0 3$.

Table 12. Regression Results on R&D Investment and Financial Performance through R&D Output

DV	Model	IV	Coefficients	t	P>|t|	R^2	Remark
ROI	13	Cons-	-0.016	-0.24	0.807	0.277	Reject $H_0$3
		RDr	1.041	7.60	0.000		
		Patent	0.014	6.52	0.000		
	14	Cons-	-0.053	-0.84	0.399	0.290	
		RDh	0.306	8.29	0.000		
		Patent	0.013	6.46	0.000		
ROIC	15	Cons-	-0.033	-0.41	0.681	0.235	
		RDr	1.133	6.56	0.000		
		Patent	0.015	5.69	0.000		
	16	Cons-	-0.071	-0.88	0.377	0.233	
		RDh	0.302	6.43	0.000		
		Patent	0.015	5.81	0.000		
ROA	17	Cons-	-0.078	-1.60	0.110	0.271	
		RDr	0.731	6.94	0.000		
		Patent	0.012	7.62	0.000		
	18	Cons-	-0.105	-2.19	0.029	0.289	
		RDh	0.226	8.01	0.000		
		Patent	0.012	7.47	0.000		
ROE	19	Cons-	-0.257	-2.16	0.031	0.271	
		RDr	1.464	5.68	0.000		
		Patent	0.032	8.23	0.000		
	20	Cons-	-0.317	-2.70	0.007	0.295	
		RDh	0.500	7.25	0.000		
		Patent	-0.016	-0.24	0.807		
ROI	21	Cons-	-0.187	-2.45	0.015	0.262	
		RDr	1.126	8.25	0.000		
		NIA	0.013	5.39	0.000		
	22	Cons-	-0.208	-2.74	0.006	0.269	
		RDh	0.324	8.62	0.000		
		NIA	0.012	4.87	0.000		
ROIC	23	Cons-	-0.292	-3.08	0.002	0.241	
		RDr	1.155	6.81	0.000		
		NIA	0.018	6.10	0.000		
	24	Cons-	-0.321	-3.38	0.001	0.234	
		RDh	0.299	6.35	0.000		
		NIA	0.018	5.85	0.000		
ROA	25	Cons-	-0.254	-4.34	0.000	0.260	
		RDr	0.785	7.51	0.000		
		NIA	0.013	7.00	0.000		
	26	Cons-	-0.267	-4.61	0.000	0.272	
		RDh	0.235	8.17	0.000		
		NIA	0.012	6.42	0.000		
ROE	27	Cons-	-0.708	-4.92	0.000	0.255	
		RDr	1.623	6.33	0.000		
		NIA	0.034	7.33	0.000		
	28	Cons-	-0.724	-5.13	0.000	0.274	
		RDh	0.524	7.47	0.000		
		NIA	0.031	6.67	0.000		
DV mean Dependence Variable; IV mean Independence Variable							

Where is there a clear mediating effect in SOP 3 from model 13 to model 28? The regression coefficient of RDr to ROI was 1.041, whereas the regression coefficient of RDh to ROI was 0.306, suggesting that RDr and RDh influence ROI through patents, with patents playing a partial mediating role in this case. R&D investment influences the financial performance of enterprises through its output.

In other words, R&D investment first boosts the company's output of innovations, which in turn boosts the company's profitability and competitiveness in the market, thus indirectly enhancing the financial performance of the business.

Model 20 is the best in SOP 3 and has an R^2 of 0.295, which is higher than that of the other models. It's illustrated that ROE is strongly affected by RDh through patents.

Zhao and Zhang (2021) investigated how R&D activity influences firm performance when NIA acts as a mediator. The findings indicate that one of the main mediating factors connecting R&D expenditure and company success is R&D output. Zhang L (2024) provide evidence in the Chinese

context to support the mediating effect of R&D outputs. Their research further highlights the important role of R&D output in boosting corporate financial performance.

3.4. Proposed A Development of Financial Performance Test Model

This study mainly studies the effect of R&D investment on financial performance, with R&D output as the mediating variable and company size and nature of ownership as moderating variables. This study examines the relationship between R&D investment and firm performance, as illustrated in Figure 2.

R&D investment significantly impacts financial performance, according to the data and model presented in Chapter 3. Specifically, both RDr and RDh strongly correlate with ROI, ROIC, ROA, and ROE. This result suggests that a company's financial performance improves as its RDr and RDh increase, thereby rejecting $H_0 1$.

In Chapter 3, this study tests the hypotheses for SOPs 1 through 3 using simple linear regression and mediated linear regression, respectively. The results show a positive correlation. Given this, it can use R^2 as an effective indicator of each model's explanatory strength. For this reason, this study uses R^2 as the basis above and select the regression model with the strongest explanation for each hypothesis.

The best model to illustrate SOP 1 is below:

$$ROI=-0.006+0.389RDh-0.008Lev-0.048Cash-0.008Growth-0.004Loss+0.001Indep-0.006Dual-0.023Top5+0.003TQ+0.003ListAge+0.002Big4+\sum Year+\sum Industry+\varepsilon_{it} \quad \text{(Model 2)}$$

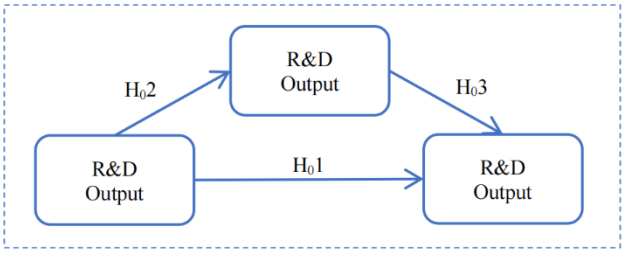

Figure 2. A Development of Financial Performance Test Model

R&D investment significantly impacts R&D output, as the data and model of SOP 2 further demonstrate. RDr and RDh positively influence NIA and patents. By increasing RDr and RDh, this study can encourage enterprises to produce more innovative results, thereby enhancing R&D output.

The best model to illustrate SOP 2 is below:

$$NIA=16.881+5.457RDh-0.088Lev-0.048Cash-0.009Growth+0.097Loss-0.004Indep+0.053Dual-0.266Top5+0.033TQ+0.028ListAge-0.077Big4+\sum Year+\sum Industry+\varepsilon_{it} \quad \text{(Model 12)}$$

SOP 3's data and model show that investing in R&D significantly impacts financial performance by introducing R&D output. The research results show that RDr and RDh not only directly affect financial performance but also indirectly promote it by increasing R&D output. This deepens our understanding of the impact of R&D investment through NIA and patents on financial performance.

The best model to illustrate SOP 3 is below:

$$ROE=-0.317+0.500RDh+0.030Patent+0.058Lev-0.130Cash+0.004Growth-0.034Loss+0.001Indep-0.028Dual-0.020Top5+0.009TQ+0.013ListAge-0.016Big4+\sum Year+\sum Industry+\varepsilon_{it} \quad \text{(Model 20)}$$

4. Conclusions

Using simple linear regression, this study looks at how R&D spending affects financial performance. RDr and RDh have a big effect on ROI, ROIC, ROA, and ROE, which is similar to what Hao Jielie found (Hao J.L., 2019). Chinese NEV enterprises utilize a combination of R&D capital and manpower investment to foster technological innovation. RDr provided the necessary resources for R&D equipment, materials, and external collaboration, while RDh provided critical technical and intellectual support (Zhang L., 2024). The combination of the two can accelerate technological breakthroughs and new products, enhance Chinese NEV enterprises in the market (Chen and Zhao, 2022), and promote financial performance, such as ROI, ROIC, ROA, and ROE.

RDr and RDh have a big effect on patents and NIA, as shown by simple linear regression Lei, Z. H., & Ran, Y., 2022; Chen, Y., et al., 2023) in the study. R&D provides the necessary financial support for R&D activities, enabling the procurement of necessary resources such as equipment, materials, and technology platforms. RDH boosts Chinese NEV firms' innovation, with skilled teams enhancing tech development, increasing patents, and improving tech transfer efficiency. Growing RDr and RDh enables Chinese NEV firms to accumulate tech knowledge, enhancing current and future R&D, sustaining long-term innovation, and boosting R&D output.

The accumulation of patents and NIA can further promote the RDr, RDh, ROI, ROIC, ROA, and ROE in Chinese NEV enterprises (Zhao, Y., et al., 2021). Increasing R&D investment enables Chinese NEV firms to produce more patents and innovations, improving IP protection and market competitiveness. This leads to higher technical barriers and better financial performance, including higher ROI and ROE. Patents, as intangible assets, provide Chinese NEV firms with stable technology licensing revenue and market share over time. Transforming R&D into market-ready products enhances ROA and ROIC.

5. Recommendations

Two recommendations could potentially enhance investment in RDr, RDh, ROI, ROIC, ROA, and ROE. On the one hand, the Chinese government should introduce and improve tax incentives and subsidies to support the R&D of NEV companies, such as increasing the R&D cost deduction before taxes and simplifying the application process so as to encourage enterprises to continue to increase RDr and RDh. On the other hand, new energy vehicle companies should incorporate R&D investment into their long-term strategies, establish a special R&D department and project evaluation system, evaluate projects according to market prospects and technical potential, and prioritize resources to R&D projects with high growth and market prospects.

To enhance the influence of RDr and RDh on patents and NIAs, our research proposes two key recommendations. On the one side, the NEV industry association should formulate an industry technology roadmap to provide R&D guidance for different market segments (such as power batteries, intelligent control, etc.) and help enterprises focus on the technology

direction with the most market potential. Industry associations should regularly hold technical exchange activities and innovation exhibitions to help enterprises share technological achievements and market information and enhance the overall innovation ability of the industry. On the other side, the NEV companies should select market segments according to their own scale and resource advantages and continuously optimize product design through user research, product testing, and other means to ensure that products can meet market demand. Businesses can build a competitive advantage in the market by avoiding direct competition with large enterprises through flexible innovation strategies and focusing on specific market segments.

The discovery of a true interaction among RDr, RDh, Patent, NIA, ROI, ROIC, ROA, and ROE leads to three recommendations. Firstly, the government should strengthen the intellectual property protection of R&D achievements of new energy vehicles, provide rapid patent application and authorization channels for enterprises and universities to cooperate with each other in industry, education, and research, provide prompt protection of joint R&D's intellectual property rights, and lower the possible risks for technology transformation partners. Secondly, new energy vehicle companies should establish a sound R&D risk management mechanism, conduct regular risk assessment and hierarchical management of technological innovation projects, and formulate alternative plans for high-risk projects to reduce uncertainty in the R&D process. Simultaneously, the company enhances its risk control ability by introducing professional risk management personnel or external consultants. Thirdly, universities can collaborate with new energy vehicle enterprises to establish laboratories or innovation centers, where they can jointly conduct R&D experiments, share R&D risks, and foster technological innovation. Universities can also provide enterprises with resource support, such as scientists and experimental equipment, to improve the success rate of R&D projects and quickly transform research results into marketable products.

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