



Can Innovation in New Energy Vehicle Companies Improve Financial Performance

—Empirical Evidence from Chinese Listed Companies

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Abstract. This paper takes A-share listed companies in China's Shanghai and Shenzhen stock markets from 2009 to 2023 as samples to empirically test the impact of innovation in technology, management, and knowledge dimensions on financial performance of new energy vehicle (NEV) enterprises. The research results indicate that NEV companies cannot have a significant impact on financial performance through technological innovation, while management innovation has a significant improvement effect on financial performance. Knowledge innovation has a certain improvement effect on financial performance, but the effect is not significant. The heterogeneity analysis of enterprise ownership shows that non-state-owned enterprises have a greater positive impact on financial performance compared to state-owned enterprises in terms of innovation; The analysis of geographical heterogeneity shows that the positive impact of enterprise innovation on financial performance in the eastern region is more pronounced than in the central and western regions.

Keywords: New Energy Vehicle (NEV); Environment; Energy; Innovation; Financial Performance

1 Introduction

In the context of escalating energy and environmental challenges, technological innovation and sustainable development are increasingly becoming pivotal factors in driving national economic growth. China's formulation of environmental sustainable development strategy has always relied mainly on ecological civilization, which requires the implementation of technologies to reduce pollution. One of these technologies is NEV, which are the core of China's automotive technology transformation and upgrading [1]. Nations are striving to reduce carbon emissions and enhance energy efficiency through the advancement of NEV technologies [2], NEVs have lower operating costs and are popular among the public in Europe [3]. Due to the low carbon emissions of NEVs, they hold an extremely important significance for achieving the ambitious goals of net-

zero emissions and “carbon peak, carbon neutrality” [4]. With the continuous improvement of people's awareness of green economy, energy conservation and emission reduction, the demand for NEVs has also been increasing year by year [5]. The development of NEV enterprises to a certain extent reflects the innovation trend of Chinese new energy enterprises. Therefore, enhancing innovation capabilities is of crucial importance for the long-term growth of Chinese NEV companies [6].

In recent years, China has implemented a series of subsidy-based policies to promote the development of NEV enterprises, ranging from the subsidy reduction plan initiated in 2016 to the dual-credit policy introduced in 2017. The dual-credit policy represents a further development of the subsidy reduction policy, optimizing the financial structure of NEV enterprises [7]. The country stimulates the innovation enthusiasm of enterprises to enhance their competitiveness and achieve financial performance improvement [8]. However, due to the early stage of technology development in China's NEV enterprises, they may face many challenges, including insufficient innovation capabilities, gradually weakening growth effects of green innovation achievements, and high dependence on government subsidies [9]. In the field of financial performance research for NEV companies, the majority of studies treat innovation capability as a secondary variable, focusing more on the role of national policies. Few studies directly explore the intrinsic relationship between corporate innovation capability and financial performance. Therefore, there is an urgent need for in-depth and detailed research on the relationship between innovation and financial performance in NEV companies. This paper aims to construct a precise and efficient innovation evaluation system to reveal the key drivers and pathways for enhancing innovation in NEV companies, thereby providing theoretical support and empirical evidence for the development and improvement of China's NEV industry.

The marginal contribution of this paper may include: First, constructing an innovation evaluation system for NEV enterprises from the dimensions of technology, management, and knowledge, studying the impact of enterprise innovation on financial performance, broadening the path of innovation development, providing a new analytical perspective for NEV enterprises to enhance financial performance, and enriching the research on the constituent elements of innovation in NEV enterprises to a certain extent, which has practical application value. Second, this study analyzes the relationship between innovation and financial performance in NEV companies with different ownership structures and geographical locations, revealing the varying impacts of heterogeneity factors. This analysis provides a basis for formulating effective development strategies for China's NEV enterprises.

2 Literature Review and Research Hypothesis

Innovation refers to the organizational ability of enterprises to achieve market value or product profit growth by optimizing resource allocation [10]. Previous literature has studied the relationship between corporate innovation and financial performance from multiple dimensions, mainly including the relationship between innovation and financial performance in three dimensions: technology, management, and knowledge.

2.1 Technological Innovation and Financial Performance

Technological innovation plays a significant role in facilitating the transformation of scientific and technological achievements into practical applications. The development of China's NEV industry must be driven by technological research and development, promoting the integration and innovation of the industry chain, as well as intelligent upgrading [11]. It has also been suggested that there is a non-linear relationship between technological innovation and financial performance [12]. Scholars have also demonstrated through empirical analysis that the impact of technological innovation on financial performance has a certain threshold effect [13]. Based on the above literature, this paper concludes that the relationship between technological innovation and financial performance of NEV enterprises is uncertain, and therefore hypothesis 1 is proposed.

Hypothesis 1: The effect of technological innovation on financial performance of NEV enterprises is not significant

2.2 Management Innovation and Financial Performance

The managerial efficiency of a firm moderates the interplay between technological innovation and financial performance to some extent, particularly in the realm of managerial innovation, where its impact on technological innovation is especially pronounced, effectively enhancing the efficiency with which technological innovation translates into corporate performance [14]. Enterprises with a sense of management innovation can effectively commercialize the results of technological innovation, bring additional economic benefits to the enterprise, and then promote the sustainable growth and development of the enterprise. Accordingly, this paper proposes hypothesis 2.

Hypothesis 2: Management innovation in NEV enterprises can significantly improve financial performance

2.3 Knowledge Innovation and Financial Performance

The development of NEV industry is essentially a knowledge driven innovation process, involving the creation, evolution, and transformation of knowledge into intellectual property achievements. This process requires continuous development of new methods and exploration of new discoveries to gain core competitiveness and create new value. Data on corporate patent applications is a key indicator of a company's innovation results, and the number of patents has a significant positive impact on the improvement of corporate performance [15]. However, some studies suggest that there is an inverted "U" - shaped distribution between the number of corporate patents and R&D investment. Based on this, this paper proposes hypothesis 3.

Hypothesis 3: Knowledge innovation in NEV enterprises can improve financial performance to a certain extent, but the effect is not obvious.

3 Sample Screening and Model Design

3.1 Sample Sources and Data Screening

This paper examines NEV listed companies in China from 2009 to 2023 as research subjects. The data primarily originates from the CSMAR database. Employing textual analysis methods, enterprises with "new energy" or "electric vehicle" in their business scope were identified, yielding a sample of 470 NEV companies with 5,671 observations. To mitigate the impact of outliers, a 5% winsorization was applied to the main variables.

3.2 Description of Variables

Dependent Variable. The dependent variable of this paper is financial performance. Referring to previous literature, the total asset net profit margin (roaa) is selected to measure the financial performance of the enterprise.

Independent Variables. The independent variables of this article are enterprise innovation, and this paper constructs an innovation evaluation system based on three dimensions: technology, management, and knowledge. Measure the proportion of R&D personnel in the dimension of technological innovation (rdpratio); The dimension of management innovation should be measured using employee labor productivity (elp); The dimension of knowledge innovation is measured by the number of patents (lnpatents).

Control Variables. Drawing on previous relevant literature, this paper selects the chairman's shareholding ratio (chairmanhr), the general manager's shareholding ratio (mholdratio), and company size (size) et al. as control variables. Additionally, fixed effects for year (year), industry (ind), and company (company) are controlled. The detailed variable design is presented in Table1.

3.3 Model Design

This paper constructs the following three models to examine the impact of innovation in technology, management, and knowledge dimensions on financial performance of NEV enterprises:

$$roaa_{it} = \beta_0 + \beta_1 rdpratio_{it} + \alpha Ctrl_{it} + \sum year + \sum ind + \sum company + \varepsilon_{it} \quad (1)$$

$$roaa_{it} = \beta_0 + \beta_1 elp_{it} + \alpha Ctrl_{it} + \sum year + \sum ind + \sum company + \varepsilon_{it} \quad (2)$$

$$roaa_{it} = \beta_0 + \beta_1 lnpatents_{it} + \alpha Ctrl_{it} + \sum year + \sum ind + \sum company + \varepsilon_{it} \quad (3)$$

where, i represents enterprise, and t denotes the year in which the enterprise operates. $roaa$ indicates financial performance, $rdpratio$ represents technological innovation, elp denotes managerial innovation, $Inpatents$ signifies knowledge innovation, and $ctrl$ refers to a series of control variables. $\Sigma year$ represents year fixed effects, Σind indicates industry fixed effects, and $\Sigma company$ denotes company fixed effects. $\mathcal{E}$ represents the residual.

Table 1. Variable design

Variable Code	Variable Name	Calculation Method
roaa	financial performance	net profit/ total assets at the end of the period
rdpratio	fatio of R&D staff	number of R&D staff / number of employees
elp	employee labor productivity	ln (management expenses/operating income)
Inpatents	number of patents	ln(number of patents)
chair-manhr	chairman's shareholding ratio	the proportion of the chairman's shareholding in the total share capital
mholdratio	general Manager's Shareholding Ratio	the proportion of shares held by the general manager to the total share capital
size	company size	ln (total assets)
cashflow	cash ratio	net cash flow from operating activities/total profit
top3	shareholding concentration	The sum of the shareholding ratios of the top three major shareholders
msratio	executive shareholding ratio	total executive shareholding/total owner's equity
idratio	proportion of independent directors	number of independent directors/number of directors
rgra	revenue growth rate	increase in operating income/total operating income last year
age	enterprise age	ln (year - year of listing)
oneboss	Whether the chairman and general manager are the same person	1 represents the same person, 0 represents not the same person

Note: For specific explanations of variables, please refer to the data explanation in CSMAR database

4 Empirical Analysis

4.1 Descriptive Statistical Analysis

The descriptive statistics of the main variables in this paper are shown in Table2, which shows that there are no more extreme outliers in the data, and the application of sample data for empirical analysis is relatively robust and reliable.

Table 2. Descriptive statistics of variables

variable	mean	sd	min	p50	max
roaa	0.041	0.052	-0.080	0.039	0.149
rdpratio	0.174	0.123	0.000	0.144	0.847
elp	13.891	0.798	12.630	13.782	15.558
lnpatents	2.800	2.477	0.000	3.135	11.212
chairmanhr	0.089	0.137	0.000	0.001	0.748
mholdratio	0.054	0.109	0.000	0.000	0.718
size	22.246	1.328	20.252	22.027	25.080
cashflow	1.064	1.733	-2.206	0.839	5.574
top3	0.476	0.169	0.048	0.467	0.983
msratio	0.018	0.062	0.000	0.000	3.033
idratio	0.371	0.051	0.143	0.333	1.000
rgra	0.264	0.461	-0.345	0.142	1.538
age	1.657	1.160	0.000	1.946	3.466
oneboss	1.706	0.456	1.000	2.000	2.000

4.2 Benchmark Regression Analysis

This paper empirically tests the impact of three dimensions of innovation on financial performance based on the models (1)-(3) constructed in the previous section, and the results of the benchmark regression are shown in Table3.

Table 3. Benchmark regression results

variable	mod (1)	mod (2)	mod (3)
rdpratio	0.002		
elp		0.019***	
lnpatents			0.001*
control variables	yes	yes	yes
year	yes	yes	yes
ind	yes	yes	yes
company	yes	yes	yes
_cons	0.213***	0.046**	0.232***

Note: *, **, *** respectively indicate significance at the 10%, 5%, and 1% levels

As shown in Table3, the coefficient for *rdpratio* in Model (1) is 0.002, which does not pass the significance test. This validates Hypothesis 1: the impact of NEV enterprises' technological innovation on financial performance is not significant. In Model (2), the coefficient for *elp* is 0.019, which is significant at the 1% level. This confirms

Hypothesis 2: management innovation in NEV enterprises can significantly enhance financial performance. In Model (3), the coefficient for *Inpatents* is 0.001, which is significant at the 10% level, but it barely reaches the threshold for significance at the 10% level, indicating a weak effect. This supports Hypothesis 3: knowledge innovation in NEV enterprises can improve financial performance to some extent, but the effect is not pronounced. Hypotheses 1-3 are all validated; however, the robustness of the research findings requires further validation through robustness test.

4.3 Robustness Test

In order to test the robustness of the empirical analysis, this paper adopts two methods for robustness testing: (1) Changing the calculation method of the net profit margin of total assets, using the *roab* calculated by "net profit/average total assets" as the dependent variable; (2) Using the return on equity (*roe*) as the dependent variable, the calculation method is "net profit/year-end balance of net assets". The robustness test results are shown in Table4.

The robustness test results, as depicted in Table4, indicate that the coefficients for *rdpratio* are not statistically significant, while the coefficients for *elp* are positive and significant at the 1% level. Although the coefficients for *Inpatents* are positive, they are no longer statistically significant. This further corroborates the robustness of the empirical findings presented in this paper.

4.4 Heterogeneity Analysis

The previous section analyzes the overall situation of the sample, but since NEV enterprises have certain heterogeneity, and these heterogeneities may lead to different analysis results, this paper further analyzes the heterogeneity in terms of the nature of ownership and geographic location.

Table 4. Results of robustness test

variable	roab robustness test			roe robustness test		
	(1)	(2)	(3)	(1)	(2)	(3)
<i>rdpratio</i>	0.003			-0.012		
<i>elp</i>		0.019***			0.037***	
<i>Inpatents</i>			0.001			0.001
control variables	yes	yes	yes	yes	yes	yes
year	yes	yes	yes	yes	yes	yes
ind	yes	yes	yes	yes	yes	yes
company	yes	yes	yes	yes	yes	yes
_cons	0.144***	-0.007	0.175***	0.094	-0.207***	0.137***

Note: *, **, *** respectively indicate significance at the 10%, 5%, and 1% levels

Nature of Ownership. Different nature of ownership may lead to differences in corporate resources. This paper distinguishes the sample aggregate into state-owned enterprises and non-state-owned enterprises, and tests the impact of their three dimensions of innovation on financial performance respectively, and the results of the study are shown in Table5.

Table 5. Heterogeneity analysis of the nature of ownership

variable	state owner			non state owner		
	(1)	(2)	(3)	(1)	(2)	(3)
rdpratio	-0.041			0.006		
elp		0.028***			0.019***	
Inpatents			0.001			0.001*
control variables	yes	yes	yes	yes	yes	yes
year	yes	yes	yes	yes	yes	yes
ind	yes	yes	yes	yes	yes	yes
company	yes	yes	yes	yes	yes	yes
_cons	-0.189	-0.235***	-0.009	0.230***	0.079***	0.261***

Note: *, **, *** respectively indicate significance at the 10%, 5%, and 1% levels

As shown in Table5, the analysis of the heterogeneity of the nature of ownership shows that the *rdpratio* and *elp* coefficients do not differ significantly between state-owned and non-state-owned enterprises, while the *Inpatents* coefficients exhibit a positive significance that is significantly higher in non-state-owned than state-owned enterprises.

Geographic Location. Different geographic locations may lead to the existence of heterogeneity of enterprises, this paper distinguishes the sample overall into the eastern, central and western regions, and analyzes the heterogeneity of them separately, and the results are shown in Table6.

As shown in Table6, the results of geographic location heterogeneity analysis indicate that the coefficients of *rdpratio* and *elp* are not significantly different in the eastern, central and western regions, but the coefficients of *Inpatents* show a positive impact on financial performance in the eastern region and are significant at the 1% level, while there is no significant impact in the central region, and in the western region there is even a significant negative impact.

Table 6. Analysis of geographic location heterogeneity

variable	eastern region			central region			western region		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
rdpratio	0.012			-0.031			-0.045		
elp		0.019***			0.020***			0.021***	

Inpatents			0.002***			-0.0005			-0.002*
control variables	yes	yes	yes	yes	yes	yes	yes	yes	yes
year	yes	yes	yes	yes	yes	yes	yes	yes	yes
ind	yes	yes	yes	yes	yes	yes	yes	yes	yes
company	yes	yes	yes	yes	yes	yes	yes	yes	yes
_cons	0.189***	0.046*	0.232***	0.137	0.041	0.235***	0.580***	0.005	0.200***

Note: *, **, *** respectively indicate significance at the 10%, 5%, and 1% levels

5 Conclusions

This paper empirically examines the impact of innovation on financial performance of NEV enterprises in the three dimensions of technology, management and knowledge. The conclusions of the study are as follows:

1. Technological innovation of NEV enterprises has no significant effect on financial performance

NEV companies cannot have a positive effect on financial performance through technological innovation, which may be due to the fact that technological innovation mainly relies on R&D investment, and the positive effect of R&D investment on financial performance takes some time. Currently, China's NEV industry is still in its early stages, so the effect is not significant.

2. Management innovation in NEV enterprises has a positive and significant effect on financial performance

NEV enterprises can significantly improve their financial performance through management innovation, which can create more profits for the enterprise and thus improve its financial performance.

3. The positive effect of knowledge innovation on financial performance of NEV enterprises is not significant

NEV enterprises through knowledge innovation can improve financial performance to a certain extent, but the effect is not obvious, which may be due to the current in NEV enterprises knowledge input into the results still need a certain amount of time, geographic location analysis also shows that the knowledge innovation in the eastern region of the positive impact on financial performance is more significant, indicating that the eastern region of the knowledge innovation investment is greater than that in central and western regions.

Based on the above research conclusions, this paper proposes the following suggestions:

1. It takes some time for innovation investment to be transformed into output, so NEV enterprises should continue to increase their innovation investment and accelerate the speed of their achievements transformation.

2. The analysis of ownership heterogeneity shows that the positive impact of innovation on financial performance is more obvious in non-state-owned enterprises, so the innovation investment of state-owned enterprises should be increased, and innovation should be intensified in the multi-dimensional aspects of technology, management and knowledge in an attempt to transform innovation into performance as soon as possible.

3. The analysis of location heterogeneity shows that the positive contribution of innovation to financial performance in the eastern region is significantly higher than that in the central and western regions, which suggests that the developed regions invest more in innovation, and therefore their results are transformed faster. Therefore, the innovation investment in the central and western regions should be increased as much as possible, and welfare policies should be actively formulated to introduce high-knowledge talents to accelerate the innovation investment in the central and western regions.

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