

# Evaluating Green Environmental Performance Through Multi-Stakeholder Governance: A Comparative Analysis of NCA and fsQCA in the New Energy Vehicle Industry

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## Abstract

The emphasis on green development in China underscores the critical role of green environmental performance in achieving sustainability. This study introduces a multi-stakeholder governance perspective to evaluate enterprises' green environmental performance, utilizing a framework with five factors categorized into firm, government, and societal dimensions. Employing a combination of Necessary Condition Analysis (NCA) and Fuzzy Set Qualitative Comparative Analysis (fsQCA), it investigates specific conditions enhancing green environmental performance in new energy vehicle enterprises, drawing on a sample of 49 companies in 2021. Results indicate that high levels of green environmental performance are influenced by multiple factors, including incentives, pressures, resources, and media attention. Additionally, the study identifies a potential complementary relationship between government subsidies and green technology innovation in driving high-level green environmental performance, subject to specific conditions. These findings contribute to our understanding of corporate green environmental performance and provide practical implications for fostering sustainability in the new energy vehicle industry.

**Keywords:** enterprises in the new energy vehicle industry, governance including multiple stakeholders, environmental performance focused on sustainability, Fuzzy Set Qualitative Comparative Analysis (fsQCA), Necessary Condition Analysis (NCA)

## 1. Introduction

Since the 19th National Congress of the Communist Party of China introduced the guiding ideology of “establishing an environmental governance system involving government, businesses, society, and the public” and promoted the idea of collaborative construction, governance, and sharing in environmental protection and management, the environmental performance of companies has become a prominent subject in academic research. However, China's green environmental performance index in 2020 was disappointing, scoring only 37.3 points, placing China 120th out of 180 participating countries and territories (Hao et al., 2020). Therefore, it is imperative for China to actively seek methods to enhance its green environmental performance to effectively implement environmental protection measures. In light of this context, numerous businesses have initiated proactive measures, and the automotive sector is not an exception. Accelerating the development of new energy applications has become a crucial strategic element in the automotive sector. Within this strategy framework, the emergence of new energy vehicles is recognized as a significant trend in the current automobile industry due to their reliance on cleaner energy sources, which decreases dependence on fossil fuels and minimizes greenhouse gas emissions. However, it is crucial to consider the institutional pollution external costs associated with the manufacturing and processing stages of these vehicles (Zhenyu et al., 2021). The production of lithium batteries, essential for new energy vehicles, requires a significant quantity of chemical raw materials and heavy metals. (Youping et al., 2022). The mining and smelting of these raw materials result in the release of industrial waste emissions, exacerbating environmental issues associated with heavy metals. If heavy metal pollution is not adequately recycled and disposed of, it will continue to spread, hindering firms from achieving a high level of environmental sustainability (Briffa et al., 2020). Hence, investigating the characteristics and mechanisms that impact the green environmental performance of new energy vehicle companies is crucial for enhancing China's environment and providing

valuable insights for other sectors.

Previous research has examined the determinants of corporate environmental performance in terms of two primary viewpoints: macro and micro. At the macro level, studies have focused on understanding how social public opinion and environmental legislation impact businesses sustainability. This encompasses variables such as media exposure (Xu et al., 2018), government financial support (Wang & Zheng, 2020), and additional factors. At the micro level, research has investigated enterprise characteristics and management behaviors, exploring factors such as green technological innovation (Li et al., 2020), executive compensation incentives (A. et al., 2021), and equity nature (Qi et al., 2022). While previous research has provided valuable insights, several limitations remain. Notably, the absence of a unified environmental performance evaluation system both domestically and internationally, which makes it difficult to obtain environmental performance indicator data. Consequently, there is insufficient research on the relationship between green environmental performance and other indicators. Furthermore, the majority of studies concentrate just on elements from a singular viewpoint, and the fundamental conditions that propel the enhancement of enterprise green environmental performance, as well as the rules governing the relationship between these conditions, remain ambiguous. Lastly, the issue of green environmental performance is characterized by complex “multiple concurrent causal relationships,” involving numerous components and intricate hierarchies. This complexity extends beyond internal corporate affairs and impacts the interests and strategic future development of government officials, other stakeholders, and society at large. Hence, addressing this issue requires innovative solutions and the establishment of collaborative governance among the government, enterprises, and society (Emma, 2022). This paper applies the theory of multi-stakeholder governance and utilizes the methods of Necessary Condition Analysis (NCA) and Fuzzy Set Qualitative Comparative Analysis (fsQCA) to examine the interrelationships among various influencing factors within the “enterprise-government-society” dimensions. Its objective is to uncover the intricate causal mechanisms between multiple factors and the widely debated green environmental performance of new energy vehicle enterprises.

## **2. Literature Review and Analytical Framework**

### *2.1 Examination of Existing Literature*

The environment, as a public or quasi-public good, is characterized by its complexity and constant evolution, posing challenges to achieving equilibrium through singular approaches. Multi-stakeholder governance emphasizes the involvement of diverse entities and mechanisms to foster cooperation and collaboration among businesses, governments, and society, aiming to achieve negotiation and cooperation objectives. Traditional environmental governance, relying solely on a government-driven “top-down” approach, has proven inadequate over time. Contemporary governance theory suggests that to effectively address ecological and environmental issues, it is prudent to allocate some authority to the market or other social organizations, enabling their active participation in addressing environmental degradation challenges. Thus, the diversified governance model presents a robust agenda and policy framework for addressing environmental governance concerns, focusing on three key aspects: business autonomy, government regulation, and social governance (Zhan & Chen, 2020). This paper provides a theoretical foundation for examining the complex causal relationships of corporate green environmental performance through a review of literature from the perspectives of companies, governments, and society, employing the theory of multi-stakeholder governance in public administration.

#### *2.1.1 The Relationship Between Corporate Autonomy and Enterprise Green Environmental Performance*

Enterprise green environmental performance refers to the efficacy of firms’ interactions with the environment. Through a comprehensive review of extant literature and consideration of technological advancements, executive compensation structures, and market dynamics in the new energy vehicle industry, key determinants affecting enterprises emerge as green innovation capabilities, executive compensation incentives, and equity ownership. Green technological innovation is crucial for improving environmental quality within the new energy vehicle sector. Executive compensation incentives directly influence executives’ decisions regarding corporate environmental policies. Furthermore, the composition of executives’ equity holdings exerts varying effects on organizational environmental performance. This study specifically investigates the impact of these factors on businesses’ environmental performance.

##### *(1) Advancements in Green Technology*

Green technical innovation involves the development and implementation of novel technologies by businesses or organizations aimed at achieving environmental sustainability and optimizing resource utilization, with the aim of diminishing negative environmental effects. In light of the escalating severity of environmental pollution, new energy vehicle enterprises are striving for a harmonious development between the environment and the economy. Their research and development objectives extend beyond cost reduction and production efficiency improvement,

encompassing the pursuit of green development and the preservation of the ecological environment. According to the resource-based theory, enhancing the level of green technological innovation facilitates the advancement of environmentally-friendly operations and production within a company. This, in turn, enables the transformation of innovative accomplishments into green products, thereby enhancing the company's competitive advantage in terms of sustainability (Wu et al., 2023). This addresses the increasing customer demand for sustainability and environmental consciousness, allowing businesses to achieve greater success in sustainable growth. Enhancing the degree of green technological innovation efficiently incentivize businesses to decrease their usage of natural resources, minimize waste emissions, and mitigate pollutant releases, thereby upholding the long-term viability of the natural environment. Additionally, this will also facilitate cost reduction (Chen, 2020). Enterprises can achieve economic benefits by using green technology and processes, which efficiently decrease energy and resource consumption. Furthermore, the implementation of green technological innovation accelerates the evolution of green knowledge management. As businesses proactively adopt novel technologies and methodologies, they can more efficiently acquire, structure, and utilize knowledge pertaining to the green sector. This facilitates the conversion of knowledge into sustainable practices and promote enhancements in the environmental performance of enterprises (Saumyanjan et al., 2022). Thus, this article specifically examines the influence of green technological innovation on the environmental performance of businesses.

### (2) Incentives for Executive Compensation

According to the upper echelons theory, executives' pursuit of increased compensation may influence the implementation of company environmental plans (Yang & Xinxin, 2022). The incentive theory posits that executives who receive higher income are more likely to focus on maximizing long-term value and take proactive efforts to protect the environment. Chang et al. (2023) suggest that offering executives significant financial incentives can mitigate their self-interest motives, encouraging them to prioritize the long-term sustainable development and environmental goals of the company (Chang et al., 2023). This approach can lead to increased investment in environmental initiatives and ultimately improve the company's environmental performance. Conversely, opportunism theory asserts that executives may prioritize their personal interests over the company's environmental responsibility. Excessive executive compensation can divert additional expenditures towards meeting executive compensation obligations, thereby diminishing the availability of funds for environmental investment. In order to continue their generous salaries, CEOs may prioritize short-term financial performance, placing greater emphasis on immediate profit generation while disregarding long-term environmental consequences and sustainability. Consequently, this may lead to a decline in the company's overall environmental performance in terms of its green initiatives. In general, there is currently a lack of clarity regarding the connection between executive compensation and corporate environmental responsibility. Therefore, further analysis is necessary to understand the influence of executive compensation incentives on green environmental performance.

### (3) The nature of equity

The determination of a company's equity nature typically hinges on the ultimate control rights of its controlling shareholders. This study categorizes Chinese listed firms into two groups: state-owned equity nature enterprises (state-owned enterprises) and non-state-owned equity nature enterprises (non-state-owned enterprises) based on the ultimate control rights of their controlling shareholders. The various types of equity exert different influences on the environmental performance of businesses. State-owned enterprises, being under government control, possess distinct motivations and strategies for enhancing their green environmental performance compared to non-state-owned enterprises (Qi et al., 2022). Consequently, there are variations in their actual performance regarding green environmental practices. State-owned enterprises prioritize political consciousness and ecological protection awareness, which enables them to align closely with national policy direction and effectively implement the Party Central Committee's concept of green development. This alignment drives state-owned enterprises to enhance their green environmental performance. When new governmental policies are introduced, state-owned firms frequently assume a leading role in ensuring their successful execution. Furthermore, the State-owned Assets Supervision and Administration Commission of the State Council includes societal contributions—such as environmental enhancement, disaster mitigation, and poverty alleviation—as criteria for evaluating state-owned enterprises. This evaluation criterion aims to encourage state-owned enterprises to take on a greater role in promoting public welfare (Jiaqi & Laura, 2021). As a result, state-owned firms are likely to allocate more resources towards environmental protection compared to non-state-owned enterprises, therefore making a greater contribution towards achieving high levels of environmentally-friendly performance. Given the considerations presented above, this study selects the equitable character as the independent variable.

### 2.1.2 The Impact of Government Subsidies on Corporate Green Environmental Performance

According to the principle of negative externalities, corporations can generate environmental issues during their production and operational processes, which detrimentally affect other segments of society without requiring compensation for the resultant damage. Hence, government intervention and guidance are crucial for promoting proactive corporate environmental governance and enhancing green environmental performance. When it comes to emerging industries such as new energy vehicles, the Chinese government predominantly depends on subsidies. These subsidies are implemented through various direct and indirect policies, including electricity price subsidies and preferential treatments in corporate income tax and value-added tax. These measures are consistently extended to provide support (Wang & Zheng, 2020). The government's strong focus on environmental preservation and substantial backing of the new energy vehicle industry has greatly advanced the business in a positive manner. Nevertheless, the extent to which these efforts have markedly improved environmental performance remains debatable. Within this particular framework, the influence of government subsidies on corporate environmental performance has attracted considerable scholarly attention. Numerous studies have consistently demonstrated that government subsidies have a positive impact on enhancing corporate green environmental performance (Wang & Zheng, 2020). Thus, this paper focuses on government subsidies as a preliminary factor for conducting a detailed study on their influence on business green environmental performance.

### 2.1.3 The Relationship between Social Governance and Enterprise Green Environmental Performance

Social organizations, which are distinct from governments and companies, are assuming increasingly significant roles in national and global governance, particularly in the realm of environmental conservation (Zhan & Chen, 2020). In the multi-stakeholder governance paradigm, social organizations primarily function as overseers. The media, as a crucial mechanism for market supervision, possesses the authority to engage in public opinion oversight of corporate environmental conduct. This compels enterprises to earnestly acknowledge the importance of environmental sustainability and adopt more ecologically responsible approaches in their operations and management. Hence, the green environmental performance of new energy vehicle firms is significantly influenced by media attention. Media attention serves as a catalyst for firms to take more proactive measures in environmental preservation. Firstly, media attention employs administrative intervention tools. It draws the focus of governments and pertinent agencies, leading them to interfere via administrative methods, oversee illicit actions of corporations, and encourage firms to willingly embrace social responsibility (Yang et al., 2020). Additionally, media attention exerts an impact on corporate conduct by means of reputation systems. According to a study by Liu et al. (2022), increased media attention on a company leads to a decrease in earnings manipulation behavior by corporate executives (Liu et al., 2022). This is primarily due to the higher costs associated with manipulating earnings, particularly regarding the potential damage to the company's reputation. Media attention plays a crucial role in regulating shareholder behavior and minimizing the personal advantages of controlling shareholders, thereby encouraging executives to prioritize corporate conduct to uphold the company's reputation (Wu & Zheng, 2021). Furthermore, media attention utilizes public opinion as a means of overseeing and constraining corporate conduct. The media serves as a conduit for the public to access information. It influences public opinion on companies by disseminating up-to-date information about listed companies (Zhang et al., 2019). This encourages companies to disclose environmental information, leading to improved environmental performance.

## 2.2 Analytical Framework

Based on the information provided, it is evident that the current study findings offer valuable theoretical and practical guidance. However, most research approaches focus on examining the influence of specific elements on business environmental performance, often overlooking the collective influence of various factors. Therefore, emphasizing the interplay and alignment of components is crucial for achieving more effective green development.

The configurational perspective, which is capable of analyzing concurrent causative links and addressing challenges such as multiple paths leading to the same outcome, helps elucidate the complex causal mechanisms driving enterprise green environmental performance improvement. The multi-stakeholder governance theory framework suggests that collaboration among government, enterprises, and the public is essential for sustainable development, offering an integrated theoretical perspective for studying green environmental performance. This paper specifically examines new energy vehicle enterprises, employing a configurational perspective to analyze levels of enterprise, government, and societal influence. It explores how various factors interact and identifies multiple paths driving the improvement of enterprise green environmental performance.

The selected conditional variables include green technical innovation, executive compensation incentives, equity nature, media attention, and government subsidies. Necessary Condition Analysis (NCA) evaluates the extent to which these aspects serve as essential prerequisites for enhancing enterprise green innovation performance. Fuzzy

Set Qualitative Comparative Analysis (fsQCA) examines interaction effects among variables, thoroughly studying the interplay of various aspects to enhance combined pathways driving green environmental performance improvement in new energy vehicle enterprises, providing a conceptual foundation for exceptional environmental sustainability. Figure 1 illustrates the analytical framework.

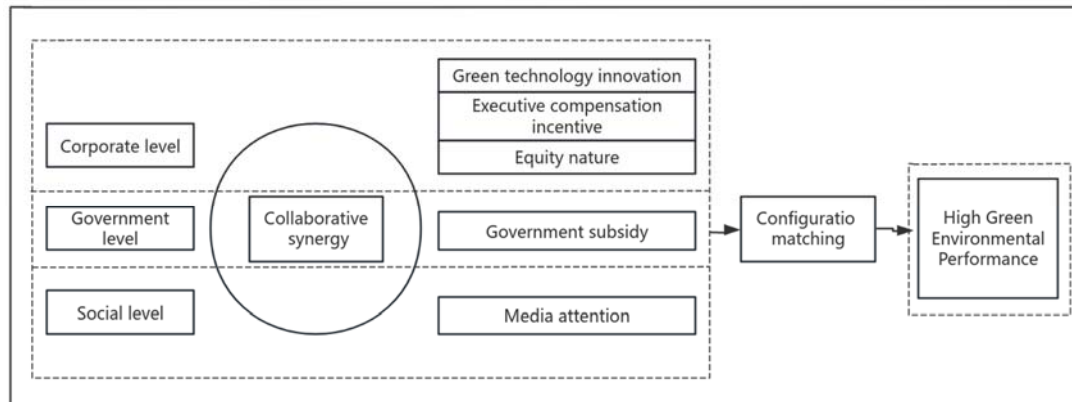


Figure 1. Presents an integrated analytical framework designed to improve the environmental performance of enterprises with a focus on sustainability

### 3. Research Design

#### 3.1 Selection of Samples and Collection of Data

The importance of energy conservation and emissions reduction is clear in light of the increasingly serious environmental issues we face. Electric vehicles are progressively supplanting conventional fuel-powered vehicles as the prevailing force in the automotive sector. Nevertheless, the production and handling of these vehicles can lead to significant levels of heavy metal and air pollution, resulting in adverse environmental consequences. Therefore, this study specifically examines firms in the new energy vehicle sector.

This research selects Chinese A-share listed new energy vehicle firms from 2021 as the sample, considering the availability of data. Data screening is performed based on the following criteria: (1) Eliminating organizations with incomplete data on important variables; (2) Excluding companies labeled as ST, \*ST, or undergoing anomalous operations. Finally, a total of 49 eligible companies are gathered as the sample.

Data samples are obtained from several databases. Green environmental performance data are sourced from the CSMAR database. Media attention data are obtained from the China National Knowledge Infrastructure (CNKI) Index database. Information regarding green technological innovation and government subsidies is gathered from company annual report disclosures and the WIND database. The remaining variable data are sourced from the Guotai An database.

#### 3.2 Research Methodology

Both domestic and international scholars often rely on conventional techniques such as multiple regression analysis in their research on green environmental performance. However, these methods have limitations in examining the synergistic impacts of multiple components. Therefore, when exploring pathways to improve enterprise green environmental performance, a blend of Necessary Condition Analysis (NCA) and Fuzzy Set Qualitative Comparative Analysis (fsQCA) is preferred over traditional statistical methods for several reasons:

Traditional regression analysis, which focuses on independent or pairwise interactions, fails to fully uncover pathways to enhance enterprise green environmental performance. In contrast, fsQCA systematically analyzes combinations of causal events and internal generating elements, providing a comprehensive evaluation of how various factors influence enterprise green environmental performance.

Moreover, while conventional regression techniques mainly assess the overall impact of variables, fsQCA allows for equifinality, acknowledging that different causal combinations can lead to the same outcome. By thoroughly analyzing interactions among different elements, fsQCA identifies various high-level pathways promoting green environmental performance, accommodating both symmetric and asymmetric relationships between variables.

Additionally, as the study primarily uses continuous variables, which pose challenges related to partial membership and variations in degree, fsQCA is more effective than traditional statistical methods in addressing these issues.

Furthermore, NCA evaluates the extent to which certain antecedent variables are essential prerequisites for the outcome variable, addressing the limitations of fsQCA in necessary condition analysis. NCA offers a more comprehensive examination of essential causal linkages, while fsQCA provides precise membership ratings, enhancing the integration of the two methods.

### 3.3 Variable Definition and Calibration

#### 3.3.1 Dependent Variable

Enterprise green environmental performance measures a company's success in protecting the environment. It is typically assessed using methods such as variable replacement, content analysis, and scoring. This research addresses the limitations of using a single assessment method by integrating three different approaches to evaluate the green environmental performance of enterprises. Drawing on the work of Che (2022) and other researchers, this study employs environmental governance performance, environmental management capacity, and environmental regulatory certification to holistically assess the green environmental performance of enterprises (Che, 2022). Listed companies adhere to the principles of disclosure, combining qualitative and quantitative information. The textual content provided by these companies is assigned a quantitative score ranging from 0 to 2. This score is used to determine the overall green environmental performance of the enterprise. The comprehensive set of indicators and the corresponding scoring system for evaluating green environmental performance can be found in Table 1.

Table 1. Comprehensive score of Green Environment Performance

Primary indicator	Secondary indicator	Tertiary indicator	Score	
Green environmental performance	Environmental governance performance	Waste reduction and control measures	0–2	
		Effluent reduction and management status	0–2	
		Dust and smoke control situation	0–2	
		Situation of Solid Waste Utilization and Disposal	0–2	
		Treatment of noise, light pollution, radiation, and other forms of pollution	0–2	
	Environmental management capabilities	Environmental regulatory certification	Implementation status of clean production	0–2
			Environmental conservation principles	0–2
			Environmental conservation objectives	0–2
			Environmental management system	0–2
			Environmental education and training	0–2
			Environmental conservation campaign	0–2
			Environmental incident emergency mechanism	0–2
			Environmental accolades or awards	0–2
			The “Three Simultaneities” system	0–2
			Key Pollution Monitoring Unit	0–2
			Pollutant emissions meet the standards	0–2
			Unforeseen environmental incident	0–2
			Environmental legal violations	0–2
			Environmental petition cases	0–2
			Whether it has passed ISO14001 certification	0–2
Whether it has passed ISO9001 certification	0–2			

#### 3.3.2 Conditional Variables Refer to Variables that Are Dependent on Certain Conditions Being Met

Green technological innovation encompasses a company's endeavors in developing and implementing environmentally friendly technology, such as clean energy and waste management. It is typically evaluated through indicators like green patents, green total factor productivity, and research and development (R&D) investment. However, green patents may be affected by factors such as prolonged authorization processes and administrative volatility, leading to discrepancies compared to actual green technological innovation. While green total factor productivity measurement is suitable for macro-level research, it may not be ideal for micro-level studies. Hence, R&D investment is commonly used as a metric to gauge green technology innovation. In this study, data on R&D investment in publicly traded new energy enterprises is utilized, transformed using natural logarithm for enhanced precision (Yan & Yin, 2020).

Executive compensation incentives aim to optimize shareholder value by motivating executives. The selection of variables for executive compensation incentives varies due to differing scholarly viewpoints. In this work, the natural logarithm of total remuneration for top directors, supervisors, and senior management is used, following prior research (Bing et al., 2021). Higher values of executive compensation incentives correspond to increased motivation for executives.

Ownership nature is categorized into state-owned and non-state-owned enterprises. State-owned enterprises are assigned a value of 1, while non-state-owned enterprises are given a value of 0 (Ren et al., 2022).

Government subsidies are financial and non-financial resources that businesses receive from government entities at various levels. This study primarily focuses on monetary assets for government subsidies, as quantifying non-monetary assets poses significant challenges. The category of “government subsidies” is located within the section of “non-recurrent losses and gains” in the financial statements of publicly traded firms using the WIND database. These subsidies are assessed as a type of financial assistance in a straightforward and intuitive manner (Lu et al., 2023).

Media attention measures the level of focus that the media gives to corporate activities. This measurement is often based on data collected from both traditional print media and internet media sources. Due to advancements in science and technology, internet media has emerged as the primary platform for spreading information, leading to a drop in the popularity of print media. Thus, this work utilizes the volume of online media obtained from the China National Knowledge Infrastructure (CNKI) Index database. The frequency of media attention indicators for each organization is determined using keyword searches and manual verification. Subsequently, the data is transformed using natural logarithmic function, with 1 added to the resulting values (Yin & Sun, 2022). A higher value signifies increased media attention and heightened social scrutiny on the organization.

Calibration is the process of assigning the observed cases to certain membership categories, converting variables into a range from 0 to 1 using fuzzy sets. This procedure necessitates the prior determination of three important values: full membership, crossover point, and full non-membership. The upper quartile, mean, and lower quartile of the sample data are used to define the full membership, crossover point, and full non-membership anchors of green innovation technology, executive compensation incentives, media attention, and government subsidies, respectively (Zhang & Du, 2019). However, the data value of ownership nature itself falls between 0 and 1 and does not need to be calibrated. The definitions and calibration anchors for each variable are displayed in Table 2.

Table 2. Variable definition and calibration

Variable name		Variable declaration	Anchor calibration		
			Completely subordinate	Intersection	Completely unrelated
Green Environmental Performance		Total sum of 21 indicators scores	15.25	11.5	6
Corporate level	Green technology innovation	Logarithm of the amount invested in research and development (R&D)	21.314	20.250	19.646
	Executive compensation incentives	Logarithm of the compensation of the top three directors, supervisors, and senior executives	16.722	16.164	15.856
	Equity nature	The value of state-owned enterprises is 1, and the value of non-state-owned enterprises is 0	1	/	0
Government level	Government subsidy	The amount of government subsidy	307055774	99935189.9	40310160.6
Social level	Media attention	Apply the natural logarithm function to the sum of the frequency of the retrieved indicators and 1	3.689	2.602	1.554

## 4. Empirical Analysis

### 4.1 Analysis of Necessary Conditions

#### 4.1.1 Necessity Analysis of NCA

This research utilizes the Necessary Condition Analysis (NCA) technique to quantitatively examine the indispensability of antecedent conditions for achieving green environmental performance. NCA is capable of discerning the essential connection between specific antecedent circumstances and outcomes, as well as quantifying the magnitude of the impact caused by various antecedent variables. The effect size is a numerical measure that falls within the range of 0 to 1, with higher values indicating stronger impacts (Wu & Zhang, 2023). This research employs two estimate techniques, namely Ceiling Regression (CR) and Ceiling Envelopment (CE), to derive the effect size as presented in Table 3. The NCA approach requires that the effect size ( $d$ ) be larger than 0.1 and attain a significant level ( $P < 0.01$ ) to meet the necessary conditions for measurement (Rotterdam School of Management et al., 2020). The analysis indicates that the effect size ( $d$ ) of government subsidies is more than 0.1, but it does not reach the minimum significance level of 0.01. This suggests that government subsidies are not considered a required condition for achieving green environmental performance. The test results indicate that green technology innovation ( $p = 0.000$ ), executive compensation incentives ( $p = 0.387$ ), equity nature ( $p = 1.0$ ), and media attention ( $p = 0.001$ ) do not meet the aforementioned requirements. Therefore, these four variables are not necessary conditions for green environmental performance.

The NCA approach is used to quantitatively examine the extent of necessary condition effects. Additionally, the bottleneck levels of each conditional variable are analyzed. CE is frequently employed for managing binary data, whilst CR is utilized for continuous or discrete variables. Given that all variables in this study are continuous, the CR method is employed to compute the corresponding data values. The results of the bottleneck analysis are presented in Table 4, indicating that government subsidies are recognized as the primary obstacle for achieving green environmental performance. To attain a green environmental performance level of 80% in an enterprise, it is necessary to have a 12.2% rate of green technological innovation and 47.3% government subsidies. However, other antecedent conditions do not have any limiting impacts.

Table 3. Results of Necessary Condition Analysis (NCA) Method

Preliminary conditions	Method	C-accuracy	Ceiling zone	Scope	Effect size	P-value
Green technology innovation	CE	100%	0.039	1	0.039	0.000
	CR	87.5%	0.098	1	0.098	0.000
Executive compensation incentives	CE	100%	0.000	1	0.000	0.387
	CR	100%	0.000	1	0.000	0.387
Equity nature	CE	100%	0.000	1	0.000	1.000
	CR	100%	0.000	1	0.000	1.000
Media attention	CE	100%	0.018	1	0.018	0.003
	CR	87.5%	0.071	1	0.071	0.001
Government subsidy	CE	100%	0.017	0.99	0.017	0.024
	CR	79.2%	0.189	0.99	0.191	0.010

Note. The variable value represents the calibrated membership value.

Table 4. Presents the analysis results of the bottleneck levels (%) using the NCA method.

Green environmental performance	Green technology innovation	Executive Compensation Incentives	Equity nature	Media attention	Government subsidy
0	NN	NN	NN	NN	NN
10	NN	NN	NN	NN	NN
20	NN	NN	NN	NN	NN
30	NN	NN	NN	NN	NN
40	NN	NN	NN	NN	NN
50	NN	NN	NN	NN	NN
60	NN	NN	NN	NN	8.7
70	NN	NN	NN	NN	28.0
80	12.2	NN	NN	NN	47.3
90	48.0	NN	NN	35.0	66.6
100	83.7	9.0	NN	82.0	85.9

Note. The data was obtained using the CR method; NN = unnecessary.



#### 4.1.2 Examination of the Necessity of fsQCA

In addition, Fuzzy Set Qualitative Comparative Analysis (fsQCA) is utilized to examine the necessity of conditions by evaluating the coherence between each antecedent variable and the explained outcome variable. Specifically, if the consistency degree exceeds than 0.9, the condition variable is classified as a necessary condition (Xiaolong et al., 2022). The results of testing essential conditions using fsQCA are presented in Table 5. All the conditional factors have a consistency of less than 0.9, indicating that no single variable at the firm, societal, or governmental level is essential for achieving high green environmental performance in enterprises. This finding aligns with the analysis results conducted by the NCA and implicitly validates the need to consider the interaction of the five antecedent variables.

Table 5. Single-factor necessity test using fsQCA method

Condition variable	Consistency	Coverage
Green technology innovation	0.727	0.752
~Green technology innovation	0.344	0.344
Executive compensation incentives	0.687	0.727
~Executive compensation incentives	0.420	0.412
Equity nature	0.276	0.563
~Equity nature	0.724	0.491
Media attention	0.659	0.674
~Media attention	0.421	0.426
Government subsidy	0.665	0.716
~Government subsidy	0.429	0.414

Note. ~ represents “not”, and the values in the table are consistency statistical indicators.

#### 4.2 Sufficiency Analysis—Potential Configurations for Generating Environmental Information Disclosure of Exceptional Quality

The truth table displays every possible combination of prerequisite conditions that might result in a certain outcome, thus representing various forms of information. Every entry in the truth table represents a logically feasible combination of conditions. In this paper, the Proportional Reduction in Inconsistency (PRI) threshold is set to 0.5 (Greckhamer et al., 2018), while the consistency threshold is set to 0.8 (Xiaolong et al., 2022). When determining the case threshold, it is advisable to consider the sample size. For small to medium samples, a setting of 1 is appropriate, while for large samples, it should not be set lower than 2 (Xiaolong et al., 2022). Given the small sample size in this investigation, the frequency threshold is established at 1, resulting in a total of 19 data points (Table 6).

Table 6. Truth Table

GTI	ECI	EN	MA	GS	number	EP	cases	raw consist.	PRI	consist.	SYM	consist.
1	1	1	0	1	1		600549	0.97561		0.948718		0.948718
0	0	1	1	0	1		600006	0.887931		0.868687		0.868687
1	1	0	0	1	2		600699, 688819	0.890805		0.844898		0.844898
1	1	0	0	0	1		603799	0.899642		0.839081		0.83908
1	0	0	1	1	2		300014, 600066	0.844875		0.816393		0.821782
1	1	1	1	1	4		000625, 000800, 600104, 600166	0.829787		0.790576		0.870317
0	1	0	0	1	1		603659	0.893617		0.776786		0.776786
1	1	0	1	1	7		002074, 002594, 300124, 300207, 300750, 601127, 601633	0.775915		0.746552		0.760984
0	1	0	1	0	2		002407, 002466	0.786942		0.653631		0.653631
1	0	0	0	0	1		600580	0.793814		0.642857		0.642857
1	0	0	1	0	2		300450, 600884	0.662921		0.527559		0.527559
0	1	0	0	0	5		002126, 002249, 002472, 002709, 300037	0.665574		0.479592		0.479592
0	0	0	0	1	2		000413, 000559	0.588608		0.353234		0.353234
1	0	1	1	1	4		000550, 600418, 600482, 600733	0.495017		0.315315		0.315315
0	0	0	1	0	1		2460	0.472826		0.256705		0.256705
0	0	0	1	1	1		300001	0.386831		0.167598		0.167598
0	0	0	0	0	9		002055, 002239, 002497, 300100, 300224, 300568, 300618, 600577, 603766	0.26827		0.067217		0.0691748
0	1	1	0	0	1		300073	0.348837		0.0666667		0.0666667
0	0	1	0	0	1		300457	0.17931		0.0165289		0.0165289

The fsQCA analysis yields three distinct types of solutions: complex, parsimonious, and intermediate. The complex solution does not account for logical remainders and depicts configurations that lack case coverage, which are not considered in the outcome analysis. Counterfactual analysis involves the introduction of logical remainders, which leads to concise and intermediate solutions. The parsimonious method produces the most straightforward outcomes

by considering only logical deductions, while the intermediate solution takes into account both basic hypothetical analyses and logical deductions that are consistent with theoretical orientations and empirical evidence, rendering it more scientifically relevant. Therefore, utilizing the intermediate and economical solutions, the paper ultimately identifies five strategies for enhancing the green environmental performance of new energy vehicle enterprises (Table 7). This approach allows for a comprehensive analysis of how to achieve high levels of enterprise green environmental performance from a holistic standpoint.

The analysis of the output findings indicates that the pathways leading to high green environmental performance display a variety of features. Five different combinations of conditions have been identified and are presented in Table 8. The overall consistency is 0.86, surpassing the sufficient condition configuration criteria. The overall explanatory power is 50%, indicating that it can account for about 50% of enterprise cases, further illustrating the diverse ways in which green environmental performance may be enhanced.

Table 7. Presents the configuration analysis results of high environmental performance in enterprises

Exogenous variable	H1	H2	H3	H4	H5
Green technology innovation		●	●	□	●
Executive compensation incentives	●	●	●	□	□
Equity nature	□	□	●	●	□
Media attention	□	□		●	●
Government subsidy	●		●	□	●
Consistency	0.88862	0.905494	0.82874	0.887931	0.844875
Original coverage	0.150225	0.168645	0.172329	0.0421613	0.124846
Unique coverage	0.023332	0.041752	0.167826	0.0376587	0.0937372
Consistency of solutions	0.861309				
Coverage of solutions	0.495702				

Note. Core conditions are denoted by the symbol “●” to indicate their existence and by the symbol “□” to indicate their absence. Non-core conditions are also denoted by the symbol “□” to indicate their existence and by the symbol “□” to indicate their absence. Spaces indicate that the condition is unrelated to the configuration.

#### 4.3 Robustness Test

To illustrate the robustness of the research findings, this paper adopts the approach of Zhang and Du (2019) and conducts a robustness test by altering the measurement of variables. Specifically, the natural logarithm of government subsidies is taken while keeping other parameters fixed (Zhang & Du, 2019). As indicated in Table 8, modifying the measuring method of variables does not lead to significant changes in the parameters and results of the configurations. The results meet the requirements of the robustness test.

Table 8. Results of stability testing

Exogenous variable	H1	H2	H3	H4	H5
Green technology innovation		●	●	□	●
Executive compensation incentives	●	●	●	□	□
Equity nature	□	□	●	●	□
Media attention	□	□		●	●
Government subsidy	●		●	□	●
Consistency	0.889151	0.905494	0.824561	0.888889	0.842105
Original coverage	0.154318	0.168645	0.173148	0.0425706	0.124437
Unique coverage	0.02456	0.0388867	0.168236	0.0376586	0.0937372
Consistency of solutions	0.857546				
Coverage of solutions	0.497749				

Note. Core conditions are denoted by the symbol “●” to indicate their existence and by the symbol “□” to indicate their absence. Non-core conditions are also denoted by the symbol “□” to indicate their existence and by the symbol “□” to indicate their absence. Spaces indicate that the condition is unrelated to the configuration.

## 5. Results Analysis and Discussion

Based on the composition and features of each pathway, the five paths mentioned above are classified into two groups of configurations under various property rights. The following analysis and explanations are offered for these two sorts of configurations.

## 5.1 Non-State-Owned Enterprises

### 5.1.1 Salary-Driven Pathway

The salary-driven pathway, corresponding to configurations H1 and H2, indicates that non-state-owned enterprises can achieve high levels of green environmental performance with proper executive remuneration incentives, even with less media attention. Executive compensation schemes often integrate environmental objectives into performance evaluations, motivating executives to prioritize environmental performance and initiate efforts. Moreover, executive incentive mechanisms are influenced by social recognition and reputation, as the public holds high expectations for corporate environmental responsibility. Non-state-owned firms tend to link CEO compensation to performance more closely, driving executives to enhance performance for personal reward and career growth. In contrast, executive compensation in state-owned firms is typically stable, potentially lacking incentives for personal gains. Therefore, increasing CEO compensation may yield more significant results for non-state-owned firms.

Furthermore, government subsidies and green technology innovation assist firms in achieving high green environmental performance. In configurations H1 and H2, where executive salary incentives are strong and media attention is low, government subsidies and green technology innovation can mutually substitute each other. Government subsidies alleviate capital constraints, support technological innovation, mitigate risks, and facilitate green innovation practices. The financial pressures of green technology innovation prompt firms to streamline operations and reduce manufacturing costs. Under specific circumstances, government subsidies and green technology innovation play equally crucial roles in enhancing firms' green environmental performance. Non-state-owned firms lacking government subsidies may focus on enhancing green technology innovation, while those with limited innovation capabilities may prioritize acquiring government subsidies.

### 5.1.2 Pressure-Driven Pathway

Configuration H5, representing the pressure-driven pathway, indicates that in the absence of significant executive compensation incentives, substantial public subsidies and considerable media attention become crucial factors driving firms to achieve commendable green environmental performance. Increase government subsidies provides economic backing for firms' technological advancements, stimulate the development of environmental protection technologies, and lower the costs associated with environmental enhancements. Simultaneously, sustained media scrutiny compels firms to adopt aggressive environmental measures to safeguard corporate reputation and enhance competitiveness. The combined influence of these factors fosters improvements in firm green environmental performance, bolsters corporate social responsibility, and promotes awareness of sustainable operations. Consequently, even in the absence of adequate executive compensation incentives, management is motivated to actively fulfill their responsibilities and mitigate dual pressures from the government and media by achieving high green environmental performance and employing other strategies beneficial for long-term enterprise development.

Further analysis suggests that the presence of green technology innovation and the absence of equity nature conditions together play a supporting effect. This may be because, compared to state-owned enterprises, non-state-owned enterprises have more operational flexibility, clearer business objectives, more sensitive market demands, and better implementation strategies. These characteristics making them more focused on innovation and research and development, more adaptable to market changes and technological advancements, and more concerned about corporate green environmental performance. When firms obtain innovation inputs, non-state-owned enterprises are likely to pay greater attention to the use of funds for research and development innovation, helping them achieve high green environmental performance.

## 5.2 State-Owned Enterprises

### 5.2.1 Resource-Driven Type

The resource-driven pathway corresponds to configuration H3. This configuration indicates that within state-owned enterprises, the effective utilization of resources, the promotion of green technology innovation, the establishment of appropriate executive incentives, and the presence of government subsidies collectively contribute to achieving higher levels of environmental performance. State-owned firms are often guided by government policies and directives, displaying higher policy compliance and enforcement in environmental preservation. They are more prone to emphasize environmental protection as a core task and execute related investments to enhance environmental performance. Moreover, as key representatives of the nation, state-owned firms are driven to aggressively execute their environmental protection obligations to maintain their public image and social reputation, consequently supporting the improvement of environmental performance.

Further analysis reveals that resource support and government involvement provide state-owned firms with

advantages in environmental protection, promoting the enhancement of green environmental performance. Green technology innovation reduces pollution during industrial processes, offering technical assistance to state-owned firms. Government subsidies offer additional resources to support state-owned firms, effectively enhancing their capacity for green innovation. Meanwhile, stronger executive incentives draw greater attention to these firms, leading to more significant direct pressure from the government in environmental protection, forcing state-owned enterprises to execute environmental strategies more aggressively. These three aspects synergistically contribute to reaching high levels of green environmental performance.

### 5.2.2 Media-Driven Type

The media-driven pathway corresponds to configuration H4. This configuration illustrates that in instances where green technological innovation, government subsidies, and executive incentives are insufficient, media attention plays a substantial driving role in achieving high levels of green environmental performance for state-owned firms. Due to the considerable duties they undertake, state-owned firms attract significant media attention. This scrutiny and the associated reputational pressure from the media compel firms to enhance their environmental protection measures to boost environmental performance and maintain a positive public image. Additionally, media attention drives firms to focus more on transparency and information disclosure. To respond to media inquiries and reports, firms must proactively share environmental data, enabling them to gain deeper insights into their green environmental performance and conduct more targeted improvement efforts. Configuration H4 reveals that, compared to other settings, media attention is particularly crucial for state-owned firms in attaining high levels of green environmental performance.

## 6. Conclusion and Implications

### 6.1 Research Conclusions

The environmental performance of organizations is influenced by both internal and external variables. Due to the complexity of these factors, their effects and mechanisms are diverse. Previous studies mainly focused on the net effects of individual factors on environmental performance, neglecting the configuration effects among different factors. This study examines the impact of different configurations on environmental performance from a configurational perspective. Specifically, focusing on new energy vehicle enterprises, this study employs Necessary Condition Analysis (NCA) and Fuzzy Set Qualitative Comparative Analysis (fsQCA) to analyze the interactive synergistic effects of five antecedent variables—green technology innovation, executive compensation incentives, ownership nature, media attention, and government subsidies—on environmental performance from a perspective of multi-stakeholder governance. It explores the multiple pathways driving the enhancement of environmental performance in enterprises. The research indicates:

Firstly, achieving high environmental performance in Chinese new energy vehicle enterprises is the result of the interaction of multiple factors, where each antecedent variable is neither necessary nor sufficient for achieving high environmental performance. Furthermore, the findings of the study reveal the existence of four configurations conducive to achieving high environmental performance in Chinese new energy vehicle enterprises, each comprising multiple factors.

Secondly, the pathways driving high environmental performance in new energy vehicle enterprises exhibit convergent characteristics, delineated into two categories contingent upon ownership nature. For non-state-owned enterprises, achieving high environmental performance entails both compensation-driven and pressure-driven pathways. The former implies that even under low media attention, executive compensation incentives can propel non-state-owned enterprises towards enhancing environmental performance. The latter predominantly relies on the synergistic effects of government subsidies and media attention to foster elevated environmental performance in new energy vehicle enterprises. Conversely, pathways for achieving high environmental performance in state-owned enterprises encompass both resource-driven and media-driven pathways. The former accentuates the combined effects of green technology innovation, executive compensation incentives, and government subsidies in elevating environmental performance in state-owned new energy vehicle enterprises. The latter underscores the pivotal role of robust media oversight as a sufficient condition for driving improvements in environmental performance among state-owned new energy vehicle enterprises.

Thirdly, within the pursuit of high environmental performance in new energy vehicle enterprises, a substitutive relationship emerges between government subsidies and green technology innovation. This dynamic offers a spectrum of pathway options for enterprises with diverse advantages and disadvantages to attain elevated environmental performance. Enterprises can strategically optimize their capabilities and allocate resources based on their unique circumstances. For instance, non-state-owned enterprises endowed with substantial executive compensation incentives yet facing relatively minimal media attention can heighten their environmental

performance by either intensifying efforts in green technology innovation or augmenting government subsidies. This array of pathway alternatives furnishes enterprises with the flexibility to refine their capacities and resource allocation, ultimately culminating in elevated environmental performance.

## 6.2 Managerial Implications

### 6.2.1 Enterprise Level

(1) Establishing a Collaborative Enterprise Environmental Management Innovation Mechanism: This study underscores the imperative of adopting a systematic approach to attain elevated environmental performance within enterprises. Enterprises should integrate various factors and consider relationships with government and society when formulating policies. By establishing collaborative mechanisms, enhancing environmental supervision, and incentivizing stakeholders, enterprises can earnestly pursue heightened environmental performance.

(2) Strengthening Executive Compensation Incentive Mechanisms: The research accentuates the efficacy of aligning executive compensation incentives with eco-friendly initiatives, such as the advancement of green technologies, to propel enhanced environmental performance. Enterprises should design scientific and reasonable executive compensation schemes to reduce self-interest and encourage active fulfillment of social responsibilities.

(3) Setting Long-Term Environmental Goals: This investigation underscores the criticality of establishing enduring environmental objectives while harmonizing green technology innovation with executive compensation incentives. Within the context of listed new energy vehicle companies, embracing forward-looking strategies holds the potential to catalyze proactive environmental stewardship and facilitate sustained developmental trajectories.

### 6.2.2 Government and Social Level

(1) Strengthening Government Financial Support to Promote Environmental Improvement: Within pathways H3 and H5, government subsidies emerge as pivotal components intertwined with the innovation of green technologies, underscoring the necessity for robust financial backing to drive technological advancements. Consequently, governments should prioritize bolstering legislative frameworks, regulatory measures, and policy guidelines while implementing standardized incentives to stimulate innovation in green technologies. Additionally, there's an urgent call to moderately increase financial subsidies for the new energy vehicle sector, thereby accelerating environmental improvements.

(2) Accentuating Reciprocal Engagement Between Government and Media: Pathway H5 elucidates the indispensable role of both government directives and media influence in achieving elevated environmental standards. This underscores the importance of highly valuing the cooperative or mutually beneficial relationship between the government and social media during environmental improvement. By establishing comprehensive cooperation mechanisms, improving government efficiency, and leveraging the influence of online media, listed enterprises can be supervised to establish environmental pollution monitoring and information disclosure platforms, thereby promoting the improvement of their environmental performance.

### 6.2.3 Theoretical Contributions

Firstly, in terms of research content, this study addresses the lacuna in existing literature by providing a comprehensive and systematic analysis of enterprise environmental performance. By exploring the impact of "enterprise-government-society" from three perspectives on enterprises' achievement of high environmental performance, it shifts from previous single perspectives to a more comprehensive overall perspective, aiding in a better understanding of the complexity and multidimensionality of enterprise environmental performance, and providing theoretical support for the formulation of comprehensive green environmental policies and strategies.

Secondly, concerning the research methods, this study integrates fsQCA and NCA, applying them to the field of enterprise environmental performance research, to offer insights for a more rigorous demonstration of the necessary relationships between enterprise environmental performance and different-level influencing factors. Previous studies have identified certain enterprise-level or government-social level factors that significantly correlate with the environmental performance of new energy vehicle enterprises. This study utilizes fsQCA and NCA to conduct necessary condition analysis, illustrating that individual factors are not necessary conditions for achieving high environmental performance, revealing the complexity and necessity of the interactions among various factors, thereby facilitating a deeper understanding of the relationships between factors influencing enterprise environmental performance.

Finally, in terms of research results, this study conducts in-depth research on the interactive matching effects and causal complexity of various antecedent variables that trigger high environmental performance in enterprises. By revealing five pathways driving high environmental performance, this study partially explains the influence of

multiple internal and external factors jointly driving enterprises to achieve high environmental performance. This not only furnishes a novel perspective for grasping the mechanisms underpinning enterprise environmental performance but also furnishes invaluable guidance for enterprises seeking to enhance their environmental performance, thereby holding practical significance.

#### 6.2.4 Limitations

This study has certain limitations. Firstly, the sample size is relatively small, with only one variable selected per influencing factor at the social and government levels. Due to the complexity of environmental performance, other external influencing factors may not have been considered. Future research could explore additional external factors affecting environmental performance. Secondly, the sample year is limited to 2021 due to the complexity and slow updating of environmental information. Future studies could extend the range of sample years to enhance the representativeness of the data.

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