

ประสิทธิภาพของ CSR นวัตกรรมทางเทคโนโลยี และมูลค่าของบริษัท:
หลักฐานจากอุตสาหกรรม NEVs ในประเทศจีน
CSR Performance, Technological Innovation, and Corporate
Value: Evidence from NEVs Industry in China

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บทคัดย่อ

ภายใต้การเปลี่ยนแปลงสภาพแวดล้อมการดำเนินธุรกิจในปัจจุบัน ความรับผิดชอบต่อสังคมขององค์กร (CSR) กลายเป็นยุทธศาสตร์ที่จำเป็นสำหรับองค์กรทางธุรกิจที่ช่วยให้องค์กรสามารถแข่งขันได้อย่างยั่งยืน การลงทุนในนวัตกรรมด้านเทคโนโลยีเป็นอีกหนึ่งปัจจัยสำคัญที่จะยกระดับมูลค่าองค์กร เนื่องจากเป็นองค์ประกอบในการยกระดับผลิตภัณฑ์และบริการในขณะเดียวกัน ก็เป็นการเพิ่มเป้าหมายด้านความรับผิดชอบต่อสังคมอย่างแข็งแกร่ง บทความนี้ ศึกษากลุ่มบริษัทด้านยานพาหนะพลังงานใหม่ (NEVs) ของจีนจำนวน 385

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บริษัท โดยมีวัตถุประสงค์เพื่อตรวจสอบ (1) ผลการดำเนินงานด้าน CSR มีความเชื่อมโยงกับการลงทุนด้านนวัตกรรมทางเทคโนโลยีของบริษัทอย่างไร และ (2) นวัตกรรมทางเทคโนโลยีมีบทบาทเป็นตัวแปรส่งผ่านระหว่างผลการดำเนินการ CSR และมูลค่าขององค์กรหรือไม่ การศึกษาครั้งนี้ใช้ข้อมูลการลงทุนด้านนวัตกรรมเทคโนโลยีที่รวบรวมจากฐานข้อมูล CSMAR และรายงานที่เกี่ยวข้องและวิเคราะห์โดยใช้สถิติเชิงพรรณนาและสถิติการถดถอย

โดยผลการศึกษาพบว่า ผลการดำเนินการ CSR ขององค์กรส่งผลทางบวกต่อนวัตกรรมทางเทคโนโลยีของบริษัทจีนในธุรกิจ NEVs จากการพัฒนาด้านการวิจัยและพัฒนาอย่างเข้มข้น และบุคลากรด้าน CSR ในขณะเดียวกันนวัตกรรมทางเทคโนโลยียังเป็นตัวแปรส่งผ่านระหว่างผลการดำเนินการ CSR กับมูลค่าขององค์กรเหล่านี้ ผลการวิจัยเหล่านี้ชี้ให้เห็นว่าการเสริมสร้าง CSR สามารถใช้เป็นกลไกเชิงกลยุทธ์ในการส่งเสริมความก้าวหน้าทางเทคโนโลยีและเพิ่มประสิทธิภาพโดยรวมของบริษัทได้

คำสำคัญ: ความรับผิดชอบต่อสังคมขององค์กร, นวัตกรรมทางเทคโนโลยี, มูลค่าของบริษัท, ตัวแปรส่งผ่าน, อุตสาหกรรม NEVs

Abstract

In the current ever-changing business environment, corporate social responsibility (CSR) is viewed as an essential strategic approach for enterprises to achieve a lasting competitive edge. Investment in technological innovation is crucial for enhancing corporate value (CV) as it is a significant means for businesses to innovate their products and services while actively meeting their social responsibilities. By analyzing 385 listed Chinese new energy vehicle (NEVs) companies with empirical study, this paper examines (1) how CSR performance relates to technological innovation

investment of these companies, and (2) whether technological innovation serves as a mediating role between CSR performance and corporate value of them. This study uses technological innovation investment data collected from the CSMAR database and related reports and analyzes them using descriptive statistics and regression analysis.

Results show that CSR performance positively impacts the technological innovation of Chinese-listed NEVs enterprises regarding their R&D intensity and R&D personnel. In addition, technological innovation is a mediating factor between CSR performance and the corporate value of these enterprises. These findings suggest that strengthening CSR can serve as a strategic lever to promote technological progress and enhance overall firm performance.

Keywords: CSR, Technological innovation, Corporate value, Mediating factor, NEVs industry

Introduction

Corporate Social Responsibility (CSR) is mainly viewed as a business concern that is actively pursued to ensure the long-term prosperity of both the companies and society (Hawn & Loannou, 2016; Kao, et al., 2018). CSR performance has been widely applied in various fields of management and economics. Technological innovation helps companies meet evolving market demands and drive industry progress by improving products and services and increasing production efficiency. Continuous technological

innovation allows companies to maintain market competitiveness, achieve sustained profitability, and ensure long-term sustainability (Singhal et al., 2022; Zorrilla et al., 2014).

Previous literature mainly focuses on the relationship between CSR performance and corporate value (Hu et al., 2018; Okafor et al., 2021; Singh et al., 2017) and the relationship between technological innovation and firm value (Neely & Hii, 1998; Rogers, 2003; Taques et al., 2021), however, there are a few studies focus on the connection of CSR and technological innovation (Bocquet, 2017; Martinez-Conesa, 2017). Companies need to invest considerable financial and human resources in technological innovation and taking CSR obligations also comes with costs. Consequently, in the short term, the budget for technological innovation may be constrained because of these competing expenses. (Anser et al., 2018; Bocquet et al., 2017). However, according to stakeholder theory and resource-based theory, the objectives of businesses extend beyond just shareholder interests. They also consider the needs of all stakeholders, including employees, customers, suppliers, and communities (Jawahar & McLaughlin, 2001).

As a result, while investing in CSR does require financial resources, it does not necessarily detract from funding for technological innovation. Companies can effectively balance and optimize resource distribution to satisfy various stakeholder demands (Chang, 2023; Lee, 2021). Furthermore, from a resource-based perspective, CSR can be considered a strategic asset for businesses. Engaging in CSR initiatives can improve a company's

social reputation and brand value, enhancing its competitiveness and attracting additional resources. These resources can, in turn, support long-term technological innovation (Mattera & Baena, 2015). Thus, although CSR involves investment, the potential long-term advantages may outweigh any short-term resource allocation challenges (Benlemlih & Bitar, 2018). Consequently, it is not contradictory for companies to pursue CSR while investing in technological innovation.

Some researchers argue that CSR and technological innovation are positively correlated. For instance, Luo (2014) used a comprehensive dataset gathered from various archival sources to explore the relationship between CSR and corporate innovation. Their empirical findings indicated that greater engagement in CSR activities correlates with enhanced innovation capabilities and an increased number of new product launches. However, some researchers take the opposite view. Upadhye et al. (2019) argued that innovative enterprises are easily questioned by consumers as they have not disclosed enough CSR to society, or there exists an information gap in CSR disclosure, suggesting that their efforts in CSR fulfillment are not acknowledged fully. NEVs companies, as innovative enterprises, invest more in technology research and development, product innovation, and R&D personnel compared to traditional companies. Therefore, it is important to further investigate the connection between investment in technological innovation and CSR performance among China's NEVs companies to

address this research gap. Grounded on the above discussion, two research questions are posited.

1. Does CSR performance positively or negatively affect technological innovation of listed NEVs enterprises in China?

2. Does technological innovation play a mediating role between CSR and CV of listed NEVs enterprises in China?

Definition of terms

Corporate social responsibility (CSR) is a firm's obligation to its stakeholders, the community, and sustainable development (Aftab, 2024). According to Carroll (1991), CSR consists of four key areas: economic, ethical, legal, and philanthropic responsibilities.

Economic CSR includes providing fair wages, supporting economic development in local communities, and ensuring the company's economic success benefits all stakeholders and society (McGrath et al., 2023).

Ethical CSR includes creating fair labor practices, ending workplace discrimination, and ensuring supply chain transparency.

Legal CSR includes compliance with environmental regulations, labor laws, and business ethics to ensure the company complies with all laws and rules.

Philanthropic CSR offers support through volunteer work, sponsoring local events, and contributing to local nonprofit programs (Lin, 2020).

Corporate value (CV) is usually regarded as the utility or wealth a business creates for itself and its stakeholders. It includes newly created value and the company's potential profitability (Camilli, 2024). Therefore, many studies use Tobin's Q as a crucial measure of a firm's value since Tobin's Q is a forward-looking indicator considering a firm's investment and growth potential (Borghesi, 2019).

Furthermore, talking about measures of technological innovation, although many researchers argue that the index of measurement of technological innovation should include R&D intensity, R&D personnel, and the number of patents (Boiko, 2022), most studies tend to focus solely on R&D intensity as a standalone measure of technological innovation (He et al., 2023; Leung et al., 2021). Among them, R&D intensity is usually defined as the ratio of R&D expenditure to an output measure; it reflects the intensity of an enterprise, industry, or country's investment in research and development and is a key indicator to measure its innovation ability and technological progress (Galindo-Rueda & Verger, 2016). R&D personnel refers to those human resources that contribute directly to research and development (R&D) activities, including highly trained scientists and engineers, technicians with high levels of technical experience, and other staff members who directly support R&D projects (Haneda & Ono, 2022). With the rapid growth of NEVs industry, NEVs companies necessitate not only funds for technology research and development, but also a substantial number of specialized professionals with expertise in R&D and technology.

Therefore, the first contribution of this paper is to utilize both R&D intensity (RDi) and R&D personnel (RDp) as indicators to measure the technological innovation of Chinese-listed NEVs companies. This approach offers a more comprehensive view of the investment in technological innovation by NEVs firms in China.

On the other hand, most previous studies on CSR have primarily concentrated on how CSR initiatives are likely to improve corporate performance (Basu & Palazzo, 2008). For instance, Singh and Misra (2021) presented empirical evidence from European firms demonstrating that CSR initiatives positively influence firm performance. Similarly, Kahloul et al. (2022) examined corporate social responsibility and found it improved corporate financial performance through the positive moderating effect of gender diversity on the board of directors. Numerous studies have indicated four kinds of relationships between CSR and CV. (1) CSR and CV positively correlated. Hu et al. (2018) supported this finding through multiple linear regression analysis of longitudinal data from China's manufacturing sector. Meanwhile, Gupta and Krishnamurti (2021) confirmed the positive impact of CSR on CV by analyzing 22,527 companies across 62 countries. (2) CSR and CV negatively correlated. Okafor et al. (2021) found that CSR investment by technology firms was associated with lower revenue and profitability. In contrast, Shirasu and Kawakita (2021) discovered that CSR activities were positively linked to long-term stock returns, although short-term CSR investments did not yield favorable stock performance. (3) There is a reversed U-shaped correlation between CSR and CV. Singh et al.

(2017) observed that the effect of CSR on firm value increased over the initial years, peaked, and then gradually diminished, while Wang et al. (2022) also identified an inverted U-shaped relationship between CSR and firm performance, noting that the presence of a founder CEO flattens this curve. (4) There is a mediating role in the correlation of CSR and CV. Martinez-Cones et al. (2017) found that innovation performance partially mediates the CSR-performance relationship, reducing the impact of CSR on corporate performance, while Zhu et al. (2019) discovered that technological innovation mediates this relationship and that environmental practices and community engagement enhance the company's social image.

Therefore, the second contribution is that this paper takes the initiative to take technological innovation as a mediating factor and examine whether it mediates between CSR and CV in the context of China's news industry. Many studies have shown that there are mediating factors in the connection between CSR and CV (Thanh et al., 2021). At the same time, we have identified a significant amount of literature exploring the relationship between CSR and CV and the connection between technological innovation and CV. This raises the question: Could CSR influence CV through technological innovation? Is it feasible that technological innovation acts as a mediator in the relationship between CSR and CV? Therefore, in light of the rapid growth of the NEVs industry in China, examining how technological innovation influences the relationship between CSR performance and firm value in NEVs companies can enhance the understanding of the relationship between the two

within the NEVs sector and offer insights into the technological innovation investment strategies of these companies.

Literature Review and Hypotheses Development

Stakeholder Theory and Social Capital Theory

Stakeholder theory holds that a company must meet stakeholders' requirements to achieve long-term success. The theory can be applied to CSR-related research because it promotes effective and ethical ways to manage organizational matters and stimulates more research to comprehend the impact of CSR in different dimensions and contexts, especially in developing economies (Harrison, 2015; Waheed & Zhang, 2022). According to stakeholder theory, companies effectively engage in CSR to address the needs of various stakeholders, including shareholders, society, and employees (Kaliannan et al., 2023). This engagement is essential for attracting talented individuals, boosting investment in technological innovation and enhancing the companies' market competitiveness. Social capital theory holds that interactions and connections within communities are essential for companies to improve community well-being and resilience through CSR activities (Rudito et al., 2023). Moreover, active CSR engagement helps companies secure policy, financial, and talent support (Luo et al., 2017), allowing them to quickly convert these valuable resources into investments in technological innovation, thereby accelerating their innovation efforts. Grounded on the above two theories, our study examines the relationship between CSR performance and technological

innovation in China's NEVs industry and further studies whether technological innovation plays a mediating role between the two.

Connection between CSR and Technological Innovation

Previous literature focuses on the relationship between CSR and CV (Hu et al., 2018; Okafor et al., 2021; Singh et al., 2017) and the relationship between technological innovation and CV (McWilliams & Siegel, 2000; Neely & Hii, 1998; Rogers, 2003; Taques et al., 2021). Among the few studies on the relationship between CSR and technological innovation, most researchers study the impact of technological innovation on CSR performance. For example, Omonijo and Zhang (2022) investigated the influence of technological innovation mechanisms driven by Chinese companies on CSR within the African mobile communication sector. Their findings indicate a positive correlation between the number of patents, technological innovation, profitability, and CSR, suggesting that advancements in technology are associated with an increase in CSR engagement, revealing that both employee skills and the number of new patents exhibit a strong positive relationship with the rate of CSR strategy adoption. Zhu et al. (2024) researched the influence of CSR on driving the sustainable financial performance of Chinese banks, finding that sustainability in financial performance can be achieved with CSR influenced by technological innovation and government regulations, which emphasized the influence of technological innovation on CSR. H. Lee and K. Lee (2021) investigated the effects of technology innovation activities, as represented by the R&D investments of Korean listed corporations on CSR performance.

Their findings indicate that technology innovation activities significantly enhance CSR performance. As can be seen, when the research perspective focuses on the impact of technological innovation on CSR performance, most of the research conclusions believe that technological innovation is positively correlated with CSR.

Meanwhile, a few scholars study the impact of CSR performance on technological innovation, but the research conclusions vary. González-Masip et al. (2019) conducted an empirical study that revealed a positive moderating effect of CSR practices on talent attraction. They concluded that firms in science and technology parks implementing CSR initiatives could effectively attract talented workers, serving as a mechanism for knowledge management spillover. This implied that the effect of CSR practices on technological innovation was positive since talents would enhance firms' willingness to introduce innovations (Mendes et al., 2023). Flammer and Kacperczyk (2016) examined whether CSR practices help to retain employees with valuable skills and knowledge, thereby mitigating the threat of knowledge spillovers, finding that enterprises with higher R&D intensity are more willing to increase CSR-related activities to reduce the threat of knowledge spillovers, showing that increasing CSR activities can help retain talents thus enhancing technological innovation. However, Gallego-Álvarez et al. (2011) analyzed the bidirectional relationship between CSR practices and innovation, finding that the bidirectional relationship between CSR and innovation efforts of R&D investment is negative, and the

effect of the former on the latter is less significant. They also noted that the relationship between innovation and CSR practices differed in different sectors. Given that there is no uniform conclusion on how CSR performance affects technological innovation, and there are great differences in different fields, it is significant to study further the relationship between the two in the NEVs industry in China. Hence, we put forward the following hypothesis¹ (H1): CSR performance positively impacts the technological innovation of Chinese-listed NEVs enterprises. As technological innovation is measured by R&D intensity (RDi) and R&D personnel (RDp) in this research, the main hypothesis¹ is divided into hypothesis 1a (H1a) and hypothesis 1b (H1b) as follows:

·H1a: CSR performance positively impacts R&D intensity of listed NEVs enterprises in China

·H1b: CSR performance positively impacts R&D personnel of listed NEVs enterprises in China

Mediating Role between CSR and CV

Research on the mediating role between CSR and CV has been explored in various studies. Kamaliah (2020) investigated the impact of corporate governance and profitability on firm value with CSR disclosure as the mediating variable. Similarly, Abbas (2020) examined how CSR mediates the relationship between total quality management (TQM) and corporate green performance (CGP), finding that TQM positively influences CGP, and CSR mediates this effect. Furthermore, Amoako et al. (2021) established a positive relationship between business ethics, CSR, green marketing, and

brand loyalty, emphasizing the mediating role of CSR and green marketing in enhancing brand loyalty. Additionally, Jihadi et. al. (2021) studied the effect of liquidity, leverage, and profitability on firm value, with CSR disclosure as a moderator. In the context of developing countries, Hamdoun et. al. (2022) aimed to analyze the mediating effect of intangible resources on the link between CSR and financial performance in Tunisian firms. These studies contribute to understanding the complex relationship between CSR, corporate value, and various mediating factors.

Among the research on the mediating role between CSR and CV, some researchers have focused on the mediating role of technological innovation. Zhang et al. (2020), taking China's listed companies as an example, studied the interaction effect of CSR and green innovation on a CV from three dimensions. Results suggested that green innovation can promote the improvement of medium- and high-level firm value, and the interaction effect between green innovation and social disclosure on firm value was a substitution effect, which will gradually weaken with the increase of firm value. Padilla-Lozano et al. (2022) explored the interplay of CSR and green innovation in boosting competitiveness in manufacturing, introducing green innovation as a mediator in the relationship between CSR and firm competitiveness. The findings revealed that both CSR and green innovation significantly influence manufacturing competitiveness within a developing economy and supported the hypothesis that green innovation serves as a mediating factor in the relationship between CSR and firm competitiveness. Based on the above

analysis, the second hypothesis (H2) is proposed as technological innovation plays a mediating role between CSR performance and corporate value of listed NEVs enterprises in China, and the main hypothesis is divided into hypothesis 2a (H2a) and hypothesis 2b (H2b) as follows:

- H2a: R&D intensity plays a mediating role between CSR and CV of listed NEVs enterprises in China

- H2b: R&D personnel play a mediating role between CSR and CV of listed NEVs enterprises in China

Research Methods and Instruments

Data and Sample

This study selects the listed NEVs enterprises in China as the research object, as China has set the goal of achieving carbon neutrality in its transport sector by 2060 by introducing NEVs (Pan et al., 2018). With their technological innovation investment collected from the CSMAR database, scores released on the CSR report from Hexun.com (covering 2017 to 2022), and corporate value and other financial data collected from the CSMAR database, this study aims to investigate the connection between CSR performance and technological innovation of Chinese NEVs enterprises as well as whether technological innovation plays the mediating role between CSR performance and corporate value of these companies. This study analyzes 555 companies listed on the Shanghai and Shenzhen stock exchanges, including 24 NEVs manufacturers, 213 NEVs parts suppliers, 55 electric power and grid equipment firms, 96 non-ferrous metal

mining companies, 11 waste resource utilization firms, 91 logistics companies, 65 NEVs battery manufacturers. Firms belonging to the NEVs industries are screened following the “Guidelines for Industry Classification of Listed Companies” issued by the China Securities Regulatory Commission, and those firms that suffered consecutive losses and do not disclose their CSR practices are excluded, and the final analysis includes 385 companies. The term “NEVs enterprises” contains new energy whole car manufacturers, manufacturers of parts and equipment, related facilities, and services. Table 1 provides detailed information about the selected NEVs firms and the industries they belong to.

Table 1

Detailed information on the new energy sector

Sector	Sub-sector	Related NEV Industry
Whole Car anufacturing	/	NEV Manufacturing Industry
Devices and Accessories Manufacturing	Motor and Engine Manufacturing	NEV Manufacturing Industry
	Energy Storing Device Manufacturing	Non-ferrous Metal Mining Industry
	Parts and Accessories Manufacturing	Power Electronic Components Manufacturing Industry
Related Facility Manufacturing	Energy Supply Device Manufacturing	NEV Manufacturing Industry
	Test Equipment Manufacturing	Equipment Manufacturing Industry
	Synthetic Material Manufacturing	Material Synthesis and Processing Industry

Sector	Sub-sector	Related NEV Industry
Related Services	Charging Services	Electric Power and Grid Equipment Industry
	Sales Services	Logistics Industry
	Maintenance and Inspection Services	Comprehensive Utilization of Waste Resources Industry

Variables

According to previous research, the influence of R&D intensity on technological innovation outcomes and firm value is not immediately effective. It is especially prone to provide mid- and long-term benefits (Diéguez et al., 2016). The role of R&D personnel is important in enhancing labor productivity in the electronics industry (Rasiah, 2010), and it is urgent to have skilled researchers and developers drive innovation and maintain a competitive advantage in a globalized market (Prasada, 2000). Therefore, this research adopts R&D intensity and R&D personnel as indicators of technological innovation of the listed NEV companies in China. Firstly, testing the effect of CSR performance on both R&D intensity and R&D personnel. Secondly, testing whether R&D intensity and R&D personnel play the mediating role between CSR performance and corporate value of these enterprises.

In this way, to test H1, R&D intensity and R&D personnel are the explained variables obtained from the CSMAR Database, while CSR performance is the explanatory variable obtained from Hexun.com of CSR reports. Control variables include asset-liability ratio (Loa), return on capital (Roc), cash ratio (Cash), total asset

growth rate (Tag), net income growth rate (Nei), age of the company (Age), payroll payable (Pp), social welfare input (Sw) and environmental protection input (Ep). To test H2, Tobin's Q, regarded as an indicator of corporate value (CV) obtained from the CSMAR Database, is the explained variable. The Tobin Q model, introduced by Nobel laureate James Tobin in 1969, is calculated as the market value of a company's total capital divided by the replacement cost of that capital, which is the sum of the market value of equity and the book value of liabilities divided by the book value of total assets (Tobin, 1969). A higher Tobin's Q indicates greater profitability and strategic competitive advantage for the firm. If Tobin's Q is above 1, it suggests that the market believes the firm's value is more than its assets' replacement cost. Therefore, it encourages investment. When Tobin's Q is less than 1, it implies that the firm is undervalued. Therefore, it discourages investment. CSR performance is also the explanatory variable, while R&D intensity and R&D personnel become the mediating variables. Control variables are the same as mentioned before. Table 2 gives the specific definitions of all variables in two hypotheses.

Table 2

Specific definitions of all variables

Variables	Types of variables		Symbol	Definition
	H1	H2		
Research and development intensity	Explained variable	Mediating variable	<i>RD_i</i>	research and development costs/operation revenue
Research and development personnel			<i>RD_p</i>	number of research and development personnel/total number of personnel
Corporate Value	/	Explained variable	<i>TobinQ</i>	total market value/total assets
Corporate Social Responsibility	Explanatory variable		<i>CSR</i>	an enterprise satisfying the interests of its stakeholders while creating profits
Asset-liability Ratio	control variable		<i>Loa</i>	total liabilities/total assets
Return on Capital			<i>Roc</i>	net income of the invested assets/total cost of the invested asset
Cash Ratio			<i>Cash</i>	ending balance of cash and cash equivalents/ current liabilities
Total Asset Growth Rate			<i>Tag</i>	(total assets end of the period–total assets initial value of the current period)/(total assets initial value of the current period)

Variables	Types of variables		Symbol	Definition
	H1	H2		
Net Profit Growth Rate			<i>Nei</i>	(net profit amount of current period-net profit year-over-year amount/(net profit year-over-year amount)
Enterprise Age			<i>Age</i>	the year of investigation minus the year of company establishment
Payroll payable			<i>Pp</i>	total salary payable-the amount paid
Social Welfare input			<i>Sw</i>	donations + grants + other public welfare expenditures
Environment protection input			<i>Ep</i>	equipment investment + operating expenses + R&D + other environmental protection expenditures

Table 3 presents the descriptive statistical findings for the variables. It includes each variable's mean, standard deviation, minimum, and maximum values. According to Table 3, the mean and standard deviation for RDi during the study period are 4.72 and 5.182, respectively, suggesting minimal variation in R&D intensity among different enterprises. In contrast, the mean and standard deviation for RDp, are 1933.551 and 6099.24, indicating significant disparities in R&D personnel across enterprises during the study period. The mean of CV is 2.655, with a standard deviation of 6.562,

reflecting some variation in corporate value among the companies studied. For the explanatory variables related to CSR, the mean and standard deviation are 5.659 and 1.986, showing minor differences in CSR during the study period. The control variables, including Roc and Cash, exhibit large standard deviations, highlighting significant differences among enterprises during the study period. Conversely, the standard deviations of other control variables are small, indicating minimal differences during the study period.

Table 3

Descriptive statistics of all variables

Variables	Obs	Mean	Std. Dev.	Min	Max
<i>RD_i</i>	329	4.72	5.182	0.004	58.064
<i>RD_p</i>	312	1933.551	6099.24	9	69697
<i>TobinQ</i>	384	2.655	6.562	0	79.474
<i>CSR</i>	320	5.659	1.986	0	8
<i>Loa</i>	380	3.836	0.526	1.679	4.984
<i>Roc</i>	301	10.558	10.867	-6.132	119.694
<i>Cash</i>	380	9.347	17.395	-22.624	25.671
<i>Tag</i>	372	1.558	2.555	-4.532	9.32
<i>Nei</i>	372	1.803	2.429	-5.089	9.074
<i>Sw</i>	276	12.769	2.843	0	18.079
<i>Pp</i>	380	17.909	1.776	13.532	23.211
<i>Ep</i>	296	0.076	0.085	0	0.439
<i>Age</i>	303	3.047	0.292	2.197	3.611

Model Specification

To explore the influence of firms' CSR performance on technological innovation, we perform the benchmark regression as follows:

$$RDi_{i,t} = \alpha_0 + \alpha_1 CSR_{i,t} + \alpha_k Controls_{i,t} + \varepsilon_{i,t}, \quad (1)$$

$$RDp_{i,t} = \beta_0 + \beta_1 CSR_{i,t} + \beta_k Controls_{i,t} + \varepsilon_{i,t}, \quad (2)$$

where $RDi_{i,t}$ and $RDp_{i,t}$ denotes the firm i's R&D intensity and R&D personnel on year t respectively. $CSR_{i,t}$ represents the firm i's CSR performance on year t. $Controls_{i,t}$ is a vector of control variables, including Loa, Roc, Cash, Tag, Nei, Sw, Pp, Ep and Age.

And to explore whether technological innovation plays as the mediating role between the connection of firms' CSR performance and corporate value, we perform the benchmark regression as follows:

$$TobinQ_{i,t} = \gamma_0 + \gamma_1 CSR_{i,t} + \gamma_1 RDi_{i,t} + \gamma_k Controls_{i,t} + \varepsilon_{i,t}, \quad (3)$$

$$TobinQ_{i,t} = \omega_0 + \omega_1 CSR_{i,t} + \omega_1 RDp_{i,t} + \omega_k Controls_{i,t} + \varepsilon_{i,t}, \quad (4)$$

where $TobinQ_{i,t}$ denotes the firm i's corporate value on year t. $CSR_{i,t}$ represents the firm i's CSR performance on year t. As mediating variables, RDi and RDp represent the firm i's R&D intensity and R&D personnel on year t. $Controls_{i,t}$ is a vector of control variables, including Loa, Roc, Cash, Tag, Nei, Sw, Pp, Ep and Age.

Empirical Results

Benchmark Results

With the ordinary least squares (OLS) regression analysis, Table 4 presents the regression findings related to hypothesis 1 (H1a and H1b), highlighting the influence of CSR on the technological innovation of NEVs enterprises in China. To guarantee the reliability of the regression outcomes, all results are fixed with year and individual effects. This study measures firms' technological innovation by R&D intensity and R&D personnel, denoted as RDi and RDp, respectively.

The regression results for R&D intensity are presented in column (1). The coefficient for the relationship between CSR and RDi is 2.2551, which is significantly positive at the 1% level. This suggests a positive correlation between CSR and R&D intensity. In other words, the better the CSR, the higher the R&D intensity. As shown in column (2), when control variables are added, the coefficient rises to 2.4011, remaining significantly positive at the 1% level. This indicates that CSR has a notable positive impact on R&D intensity, meaning that for each unit, an increase in CSR and R&D intensity is expected to increase by an average of 2.4011 units. This result validates hypothesis 1a (H1a) that CSR performance has a positive impact on R&D intensity of listed NEVs enterprises in China.

The regression results for R&D personnel are presented in column (3). The coefficient for the relationship between CSR and RDp is 580.3863, which is statistically significantly positive at the 5% level. This suggests a positive correlation between CSR and R&D

personnel. As shown in column (4), when control variables are added, the coefficient remains at 579.0734, still significantly positive at the 5% level. This indicates that CSR has a notable positive impact on R&D personnel, meaning that for each unit increase in CSR, there is an average increase of 579.0734 units in R&D personnel. This result validates hypothesis 1b (H1b) that CSR performance positively impacts the R&D personnel of listed NEVs enterprises in China.

Table 4
Results of benchmark regression based on hypothesis 1 (H1a and H1b)

	(1)	(2)	(3)	(4)
	<i>RD_i</i>	<i>RD_i</i>	<i>RD_p</i>	<i>RD_p</i>
<i>CSR</i>	2.2551***	2.4011***	580.3863* *	579.0734**
	(7.5513)	(6.3010)	(1.9863)	(1.9157)
<i>Loa</i>		-1.6618*		593.8137
		(-1.8097)		(0.2433)
<i>Roc</i>		-0.0329		42.0257
		(-1.4581)		(0.7008)
<i>Cash</i>		0.0009		80.5115**
		(0.0747)		(2.4883)
<i>Tag</i>		0.1925*		493.1718
		(1.6928)		(1.6007)
<i>Nei</i>		-0.2142		-64.9093
		(-1.1692)		(-0.1327)
<i>Sw</i>		-0.0021		-1.4e+02
		(-0.0203)		(-0.4958)
<i>Pp</i>		-0.1148		2.2e+03***

	(1)	(2)	(3)	(4)
	<i>RD_i</i>	<i>RD_i</i>	<i>RD_p</i>	<i>RD_p</i>
		(-0.3792)		(2.6712)
<i>Ep</i>		3.1079		-2.4e+04**
		(0.8851)		(-2.5313)
<i>Age</i>		0.4868		2.0e+03
		(0.0509)		(0.0794)
<i>Fixed year effect</i>	YES	YES	YES	YES
<i>Fixed individual effect</i>	YES	YES	YES	YES
<i>_cons</i>	7.6466***	12.0138	-6.8e+02	-5.1e+04
	(4.2995)	(0.4404)	(-0.4013)	(-0.6990)
<i>N</i>	271	149	261	145
<i>Adj R²</i>	-0.3004	-0.5170	-0.2698	-0.2020

Notes: *, **, and *** denote that the individual coefficient is at the 10%, 5%, and 1% level.

Table 5 examines the potential mediating effect of technological innovation on the relationship between CSR performance and corporate value. R&D intensity and R&D personnel are used as mediating variables for the regression analysis, with the findings in Table 5. To ensure the reliability of the regression outcomes, all results are fixed with year and individual effects.

The regression results regarding the relationship between CSR and R&D intensity are presented in column (1). The data indicates a strong positive correlation between CSR and R&D intensity. In column (2), the regression coefficient for R&D intensity about firm value is 0.0468, which is significantly positive at the 5% level. This suggests that an increase in R&D intensity will notably enhance firm value and that R&D intensity serves as an obvious mediating factor between CSR and firm value. This result validates

hypothesis 2a (H2a) that R&D intensity mediates CSR performance and the corporate value of listed NEVs enterprises in China.

The regression results between CSR and R&D personnel are presented in column (3). The data indicates a significant positive correlation between CSR and R&D personnel. As can be seen from column (4), the regression coefficient between R&D personnel and firm value is 0.0015, which is significantly positive at a 1% level, indicating that the increase of R&D personnel will notably improve firm value and R&D personnel play an obvious mediating role between CSR and firm value. This result validates hypothesis 2b (H2b) that R&D personnel mediate between CSR performance and the corporate value of listed NEVs enterprises in China.

Table 5

Results of benchmark regression based on hypothesis 2 (H2a and H2b)

	(1)	(2)	(3)	(4)
	<i>RD_i</i>	<i>VALUE</i>	<i>RD_p</i>	<i>VALUE</i>
<i>CSR</i>	2.4011***		579.0734**	
	(6.3010)		(1.9157)	
<i>RD_i</i>		0.0468**		
		(2.3051)		
<i>RD_p</i>				0.0015***
				(2.8091)
<i>Loa</i>	-1.6618*	-0.5232	593.8137	-0.5747
	(-1.8097)	(-0.3382)	(0.2433)	(-0.3736)
<i>Roc</i>	-0.0329	0.0058	42.0257	0.0043
	(-1.4581)	(0.1497)	(0.7008)	(0.1128)

	(1)	(2)	(3)	(4)
	<i>RD_i</i>	<i>VALUE</i>	<i>RD_p</i>	<i>VALUE</i>
<i>Cash</i>	0.0009	-0.0305	80.5115**	-0.0314
	(0.0747)	(-1.4874)	(2.4883)	(-1.4545)
<i>Tag</i>	0.1925*	0.0243	493.1718	0.0244
	(1.6928)	(0.1233)	(1.6007)	(0.1207)
<i>Nei</i>	-0.2142	0.4945	-64.9093	0.4858
	(-1.1692)	(1.5844)	(-0.1327)	(1.5570)
<i>Sw</i>	-0.0021	-0.1098	-1.4e+02	-0.1091
	(-0.0203)	(-0.6184)	(-0.4958)	(-0.6100)
<i>Pp</i>	-0.1148	0.0302	2.2e+03***	0.0171
	(-0.3792)	(0.0584)	(2.6712)	(0.0310)
<i>Ep</i>	3.1079	-1.7648	-2.4e+04**	-1.4337
	(0.8851)	(-0.2938)	(-2.5313)	(-0.2302)
<i>Age</i>	0.4868	-1.7047	2.0e+03	-1.8003
	(0.0509)	(-0.1046)	(0.0794)	(-0.1098)
<i>Fixed year effect</i>	YES	YES	YES	YES
<i>Fixed individual effect</i>	YES	YES	YES	YES
<i>_cons</i>	12.0138	10.8464	-5.1e+04	11.6797
	(0.4404)	(0.2327)	(-0.6990)	(0.2479)
<i>N</i>	149	149	145	145
<i>Adj R²</i>	-0.5170	-0.4516	-0.2020	-0.4302

Notes: *, **, and *** denote that the individual coefficient is at the 10%, 5%, and 1% level

Robust Test

To ensure the reliability of the model estimation results, robust tests of the models based on Hypothesis 1 and Hypothesis 2 are carried out.

Based on the model of hypothesis 1, the robustness test is conducted by replacing explanatory variables. The quality of CSR information is used as a replacement for the explanatory variables to assess CSR, denoted as CSRQUA. The regression findings are presented in Table 6. As indicated in column (1), the regression coefficient for CSRQUA about R&D intensity is 14.3945, which is significantly positive at the 10% level. Column (2) shows that the regression coefficient for CSRQUA concerning R&D personnel is 629.9034, with a significant positive result at the 1% level. These results align with the baseline regression outcomes of hypothesis 1, demonstrating that models (1) and (2) exhibit strong robustness.

Table 6

Robust test results based on hypothesis 1 (H1a and H1b)

	(1)	(2)
	<i>RD_i</i>	<i>RD_p</i>
<i>CSRQUA</i>	14.3945*	629.9034***
	(1.9845)	(8.3342)
<i>Loa</i>	-1.6074*	548.4025
	(-1.7648)	(0.2273)
<i>Roc</i>	-0.0325	42.7237
	(-1.4399)	(0.7156)
<i>Cash</i>	0.0010	80.5614**
	(0.0818)	(2.4987)
<i>Tag</i>	0.1852	518.7108*
	(1.6269)	(1.6873)
<i>Nei</i>	-0.2148	-85.0288
	(-1.1699)	(-0.1743)
<i>Sw</i>	-0.0094	-1.1e+02

	(1)	(2)
	<i>RDi</i>	<i>RDp</i>
	(-0.0901)	(-0.4176)
<i>Pp</i>	-0.1049	2.2e+03***
	(-0.3466)	(2.6540)
<i>Ep</i>	3.0580	-2.4e+04**
	(0.8706)	(-2.5393)
<i>Age</i>	0.7627	468.1139
	(0.0795)	(0.0185)
<i>Fixed year effect</i>	YES	YES
<i>Fixed individual effect</i>	YES	YES
<i>_cons</i>	10.7690	-4.6e+04
	(0.3944)	(-0.6411)
<i>N</i>	149	145
<i>Adj R²</i>	-0.5196	-0.1943

Notes: *, **, and *** denote that the individual coefficient is at the 10%, 5%, and 1% level

Based on the model of hypothesis 2, the robustness test is conducted by utilizing mediating variables with a one-period lag. The R&D intensity and the R&D personnel involved in the target enterprises are each delayed by one period, and the regression outcomes are presented in Table 7.

Column (1) in Table 7 shows that the regression coefficient for CSR and R&D intensity lagged by one period is 2.4983, which is significantly positive at the 1% level. In column (2), the regression coefficient for R&D intensity lagged by one period about firm value is 0.0476, also significantly positive at the 5% level. This indicates that R&D intensity lagged by one period and continues to serve as

a significant mediator between CSR performance and corporate value, aligning with the baseline regression results of hypothesis 2 and demonstrating the robustness of the model (3).

Column (3) shows that the regression coefficient for CSR and R&D personnel lagged by one period is 503.1837, which is significantly positive at the 1% level. In column (4), the regression coefficient for R&D personnel lagged by one period about firm value is 0.0038, also significantly positive at the 1% level. This indicates that R&D personnel lagged by one period continues to serve as a significant mediator between CSR performance and corporate value, aligning with the baseline regression results of hypothesis 2 and demonstrating the robustness of the model (4).

Table 7

Robustness test results based on hypothesis 2 (H2a and H2b)

	(1)	(2)	(3)	(4)
	<i>L.RDi</i>	<i>VALUE</i>	<i>L.RDp</i>	<i>VALUE</i>
<i>CSR</i>	2.4983*** (6.2937)		503.1837*** (6.5686)	
<i>L.RDi</i>		0.0476** (2.3461)		
<i>L.RDp</i>				0.0038*** (7.6222)
<i>Loa</i>	-0.7639 (-0.5425)	0.6272 (0.5652)	2.3e+03 (0.7647)	0.6572 (0.5862)
<i>Roc</i>	-0.0354 (-1.0427)	0.0146 (0.5420)	73.9339 (1.0261)	0.0110 (0.4057)
<i>Cash</i>	-0.0043	-0.0376**	-10.8579	-0.0339**

	(1)	(2)	(3)	(4)
	<i>L.RDi</i>	<i>VALUE</i>	<i>L.RDp</i>	<i>VALUE</i>
	(-0.2266)	(-2.5029)	(-0.2616)	(-2.1895)
<i>Tag</i>	0.3495	0.1275	222.3336	0.1334
	(1.3123)	(0.5984)	(0.3939)	(0.6335)
<i>Nei</i>	-0.2064	0.0624	78.4331	0.0280
	(-0.6077)	(0.2334)	(0.1088)	(0.1044)
<i>Sw</i>	0.0302	0.0001	-1.1e+02	-0.1006
	(0.1326)	(0.0008)	(-0.2143)	(-0.5167)
<i>Pp</i>	-0.2431	-0.2805	0.7942	-0.1510
	(-0.5132)	(-0.7489)	(0.0008)	(-0.3899)
<i>Ep</i>	7.4515	4.0495	-1.4e+04	5.0691
	(1.4422)	(0.9778)	(-1.2358)	(1.2088)
<i>Age</i>	24.9722	-0.8723	-1.2e+04	11.3685
	(1.4914)	(-0.0652)	(-0.3008)	(0.7359)
<i>Fixed year effect</i>	YES	YES	YES	YES
<i>Fixed individual effect</i>	YES	YES	YES	YES
<i>_cons</i>	-64.7026	6.0073	3.4e+04	-31.4636
	(-1.2807)	(0.1508)	(0.2658)	(-0.6714)
<i>N</i>	120	120	118	118
<i>Adj R²</i>	-0.6005	-0.3630	-0.8605	-0.3770

Notes: *, **, and *** denote that the individual coefficient is at the 10%, 5%, and 1% level

Discussion

This paper focuses on corporate social responsibility (CSR), technological innovation, and corporate value (CV) of NEVs industry in China, contributing to three main areas that can be further explored. Firstly, CSR performance positively influences the technological innovation of Chinese NEVs companies. This finding is

consistent with Flammer and Kacperczyk (2016), González-Masip et al. (2019), Hu et al. (2020), Luo et al. (2017) arguments that as an intangible asset, CSR engagement attracts more high-quality talents, gains financial and policy supports, thus driving the development of the firm's technological innovation. In this way, the finding of this paper addresses a gap in existing research, which has not extensively examined the relationship between CSR and technological innovation from the perspective of CSR performance and provides references for the development of NEVs enterprises in other emerging markets as well.

Secondly, R&D personnel play a mediating role in the relationship between CSR and CV in Chinese NEVs enterprises. This finding supports the idea of Boiko (2022) that factors that measure technological innovation should be broader, at least considering R&D intensity, R&D personnel, and patent number since most research chooses only R&D intensity as the indicator of technological innovation (He et al., 2023; Leung et al., 2021). Therefore, R&D personnel (RDp) is added as one of the measurement indicators of technological innovation to ensure the accuracy of the research conclusion. Considering the development of the industry, China's NEVs enterprises started relatively late, but the rapid development in recent years is inseparable from the investment of enterprises in R&D personnel. Taking Chinese NEVs leader BYD as an example, according to the data disclosed from the annual report of the company, BYD's R&D personnel totaled 69,697, accounting for 12.23% of the total in 2022; in 2023, the company's

R&D personnel totaled 102,844, accounting for 14.62% of the total, which shows that the company attaches much importance to research and development personnel. Therefore, it is reasonable to take R&D personnel as a variable indicator to measure the technological innovation investment of NEVs enterprises.

Thirdly, our research provides feasible methods and policy implications for subsequent research on technological innovation contribution in the field of NEVs industry. Our study's measurable variables and indicators prove applicability and robustness for research in the correlation between CSR, technological innovation and corporate value. For policymakers, policy preferences should be offered to NEVs enterprises that actively fulfill CSR and broader channels should be opened for their recruitment of high-tech talents, as the technological innovation of the enterprises will, in turn, enable them to engage in social responsibilities and contribute value to society continuously.

Conclusion

This study demonstrates that CSR performance positively impacts the technological innovation of listed NEVs enterprises in China. Specifically, CSR performance enhances R&D intensity and the number of R&D personnel. Additionally, the study establishes that technological innovation—specifically through R&D intensity and R&D personnel—mediates CSR performance and corporate value. These results indicate that CSR performance enhances technological innovation, boosting long-term firm performance.

This research contributes to understanding how CSR performance drives technological innovation in China's NEVs sector, highlighting the critical role of R&D intensity and personnel in transforming CSR efforts into improved corporate value. By identifying the mediating effects of technological innovation, this study provides actionable insights for NEVs enterprises aiming to leverage CSR to enhance their long-term value. The findings offer valuable implications for policymakers and industry leaders, suggesting that fostering CSR can be a strategic approach to boost technological advancements and overall firm performance. The robustness of the models reinforces the importance of integrating CSR with innovation strategies and provides a foundation for future research on the interplay between CSR and technological progress.

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