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Does one size fit all? The sector-specific impact of R&D investment intensity and CEO educational backgrounds on corporate social responsibility performance

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Abstract: Researchers emphasize the importance of CEOs' educational backgrounds in shaping the internal mechanisms of corporate governance, with recent scholarly studies highlighting the profound influence of CEOs' attributes on CSR performance. This study aims to investigate the role played by CEOs who acquired university, postgraduate, and business education, along with R&D investment intensity, on the CSR performance of manufacturing and service companies. Utilizing data from 1,632 firm-year observations of companies listed in China between 2015 and 2020, the study reveals that service companies with low-intensity R&D investment and led by CEOs with postgraduate degrees appear to outperform others in terms of CSR. However, the conclusions vary when the two sectors are examined separately. Manufacturing companies with low-intensity R&D investment outperform their counterparts in the same sector only when their CEOs have postgraduate and business education. On the other hand, service-oriented firms exhibit enhanced performance under the leadership of CEOs lacking formal business education, particularly when coupled with low R&D investment intensity. This observation contradicts the widely held assumption that MBA-educated executives are inherently more effective in driving and sustaining CSR initiatives. This study acknowledges that one size does not fit all, as CEOs' educational backgrounds have different impacts on different companies.

Keywords: *Business education, CEO education, China, Corporate governance, Corporate social responsibility, CSR, Education, EMBA, MBA, Postgraduate, R&D, Research and development, Top management.*

1. Introduction

Corporate Social Responsibility (CSR) has emerged as a critical area of study, driven by its profound implications for business operations and the substantial financial resources allocated to CSR initiatives. This growing significance has spurred extensive research across disciplines such as accounting, management, finance, and economics, reflecting a paradigm shift in contemporary management practices [1-4]. Over the past three decades, CSR has transitioned from a peripheral concern to a central focus in managerial and accounting research, underscoring its universal relevance [3, 5, 6].

In China, the urgency of CSR has been amplified by a series of corporate scandals, environmental degradation, food safety issues, and labor disputes [7]. Recent studies, such as Ang, et al. [8] highlight alarming environmental challenges, including the contamination of 40% of China's rivers, primarily due to pollution from industries like metal smelting, printing, and dyeing. These sectors, while pivotal to China's economic growth, now face mounting pressures to adopt sustainable practices and mitigate their environmental footprint. Rapid urbanization and expansion in the construction sector have further exacerbated these challenges, necessitating robust regulatory frameworks and CSR initiatives to address social and environmental concerns [9, 10]. Amidst China's economic ascent, issues such as air pollution and labor conflicts have underscored the critical need for sustainable solutions [11].

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The academic and corporate worlds have increasingly recognized the importance of CSR, particularly given the billions of dollars invested annually in CSR-related activities [1]. This has led to a surge in research exploring the drivers and outcomes of CSR practices, with a focus on identifying factors that influence their implementation [12]. Among these factors, CEO attributes—particularly educational background—and R&D investment intensity have emerged as significant determinants of CSR performance [13-17].

Studies have shown that CEOs' educational and professional qualifications play a pivotal role in shaping organizational approaches to CSR [18, 19]. Additionally, R&D investment is increasingly viewed as a strategic enabler of CSR commitments, particularly in the manufacturing sector, where its impact is most pronounced [12, 20]. However, distinctions between the manufacturing and service sectors have also been observed, with the latter placing greater emphasis on environmental stewardship, labor practices, and corporate governance [21].

This study aims to advance the understanding of CSR by examining the interplay between CEO education, R&D investment intensity, and CSR performance. Specifically, it investigates how R&D investment intensity, combined with varying CEO educational backgrounds, influences CSR outcomes. By focusing on China—a global leader in economic growth, technological innovation, and CSR advancements—this research addresses a critical gap in the literature, as most studies on corporate governance mechanisms, including CEO education, have been conducted in Western contexts [22]. Notably, significant differences exist between Eastern and Western nations in terms of corporate governance, sustainable production, and resource preservation [23].

The study reveals that CEOs with postgraduate or business education positively influence CSR performance in manufacturing firms with low R&D investment intensity. However, in service-oriented firms with similar R&D profiles, postgraduate education appears to have an insignificant impact, with CEOs lacking business education demonstrating superior performance. These findings challenge the prevailing assumption that MBA or EMBA graduates are inherently more effective in driving CSR outcomes. They suggest that while CEO education plays a role, its impact is not universally applicable and may be mediated by external factors such as industry norms, stakeholder expectations, regulatory requirements, and organizational values. This research underscores the complexity of CSR implementation, highlighting the need for a nuanced understanding of how CEO attributes and R&D investments interact within different organizational and industry contexts. It also calls for further exploration into the factors that enable or hinder the translation of academic knowledge into measurable CSR outcomes.

This paper is structured as follows: Section 2 reviews the relevant literature and presents the study's hypotheses, Section 3 explains the research methodology, Section 4 examines the results, and Sections 5 cover the conclusions.

2. Literature Review and Research Hypotheses Development

2.1. Corporate Social Responsibility (CSR)

In recent years, corporate scandals and failures have significantly tarnished the reputations of companies, challenging the traditional perception of businesses as solely profit-driven entities [2, 24]. In response, organizations are increasingly striving to redefine their identities, positioning themselves as accountable and socially responsible entities that prioritize ethical governance, trust, and environmental and social stewardship [6, 25]. This shift has sparked heightened interest among academics and professionals in exploring the roles of corporate ethics, corporate governance (CG), and CSR in enhancing organizational performance and fostering sustainable business practices [26].

The rising prominence of CSR is particularly evident in its emphasis on environmental sustainability, human rights, and ethical business practices, especially in emerging markets [27]. Carroll's widely recognized definition of CSR highlights the need for companies to fulfill their financial, legal, ethical, and philanthropic obligations [28]. Today, CSR has become deeply embedded in global corporate culture, evolving from a peripheral concern to a fundamental aspect of business strategy. It is

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now regarded as a critical element for establishing organizational credibility, legitimacy, and competitive advantage in an increasingly dynamic and socially conscious business environment Gjølberg [28].

Duarte [29] conceptualizes CSR as the proactive management of issues that extend beyond an organization's financial and legal responsibilities, encompassing social and environmental dimensions. Advocates of sustainable development argue that businesses must integrate CSR initiatives into their core operations, balancing economic objectives with social and environmental considerations [8]. This holistic approach underscores the responsibility of management to address these factors, as they significantly influence organizational performance and stakeholder relationships. The terminology used to describe CSR varies across academic and professional contexts, with terms such as Environmental, Social, and Governance (ESG), corporate sustainability, responsible entrepreneurship, and corporate citizenship often used interchangeably [30]. Despite these variations, the underlying objective remains consistent: to integrate social and environmental considerations into business strategies, thereby fostering economic success, building reputation, and earning the trust of stakeholders and local communities.

While CSR models, such as Carroll's pyramid of CSR, have provided foundational frameworks for understanding corporate responsibility, scholars have critiqued their limitations in capturing the full complexity of CSR practices. Notably, these models often fail to account for the cultural and societal contexts within which businesses operate [31]. For instance, significant differences exist in CSR adoption and implementation between Eastern and Western countries. The United States and the United Kingdom have been pioneers in areas such as sustainable production and corporate governance, driven by regulatory frameworks and cultural expectations that prioritize ethical and socially responsible behavior [23]. The rapid integration of CSR principles in Western nations highlights its transformative impact on corporate culture. However, the convergence of organizational practices is also influenced by educational and professional authorities, which play a pivotal role in shaping managerial approaches to CSR [18, 19]. These insights underscore the need for a more nuanced understanding of CSR that considers regional, cultural, and institutional differences.

2.2. Top Management and CSR

Corporate governance mechanisms, particularly management compensation, play a critical role in shaping companies' CSR performance, with CEO education emerging as a key influencing factor Cheng, et al. [13]. Smith [32] presents two contrasting perspectives on the relationship between corporate management and CSR. The normative perspective posits that companies engage in CSR activities out of a genuine desire to contribute positively to society, emphasizing altruistic motivations. In contrast, the business case perspective views CSR as a strategic tool for achieving organizational benefits, driven by enlightened self-interest rather than purely ethical considerations.

CSR initiatives are often initiated by a small group of committed managers whose personal values and beliefs align with social and environmental responsibility [29]. These individuals, often part of the top management team or dominant coalition, play a pivotal role in guiding organizational strategy. They identify environmental opportunities and challenges, interpret relevant information, assess organizational capabilities, and implement strategic changes [19]. Their deep understanding of the social and environmental impacts of their organizations motivates them to champion CSR efforts, even in the absence of external pressures or regulatory mandates. Thus, the personal convictions and leadership of these executives are instrumental in driving CSR initiatives within their organizations [13].

2.3. CEO Education and CSR

In recent decades, the expectation for companies to engage in CSR initiatives has grown significantly. While some managers have embraced this shift, others remain hesitant, often perceiving a conflict between CSR and profitability [16]. Corporate governance mechanisms, particularly

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management compensation, have been identified as critical determinants of CSR performance, with CEO education playing a central role [13]. The influence of managerial attributes, including educational background, on CSR implementation has garnered considerable attention, highlighting the importance of education and professional qualifications in shaping organizational approaches to social responsibility [18, 19].

2.3.1. The Role of CEO Education in CSR

The Upper Echelons Theory, proposed by Hambrick and Mason [33] suggests that organizations reflect the personal characteristics of their top executives. This theory provides a framework for understanding how CEO education influences organizational outcomes, including CSR performance. Higher levels of education are associated with enhanced cognitive abilities, information-processing skills, and decision-making capabilities, enabling CEOs to navigate complex social and environmental challenges effectivelyWiersema and Bantel [19] and Al-Dubai [34].

Dahlin, et al. [35] emphasize that formal education contributes to expertise development by equipping individuals with a robust knowledge base and the ability to interpret diverse information sources. This accumulated knowledge enhances problem-solving skills and fosters integrative complexity, enabling CEOs to identify and address CSR-related issues more effectively. Educational diversity within leadership teams has also been shown to improve information depth and task performance, further underscoring the link between education and CSR outcomes Dahlin, et al. [35] [35].

Bhagat, et al. [36] argue that CEO education influences competencies such as technical knowledge, cognitive flexibility, and professional networking. These attributes enable CEOs to make informed decisions, adapt to changing environments, and leverage social connections to advance CSR initiatives. Similarly, Meyer [37] highlights that highly educated individuals exhibit greater concern for social welfare and environmental sustainability, suggesting that education shapes values such as social responsibility and ethical decision-making.

Empirical studies have demonstrated a positive relationship between CEO education and CSR performance. For instance, Amore, et al. [38] and Malik, et al. [39] found that CEOs with advanced educational backgrounds are more likely to prioritize environmental and social considerations in their decision-making. This aligns with the Resource Dependence Theory, which offers valuable insights into the relationship between CEO education and CSR performance. This theory posits that managers are critical assets for organizations, providing essential resources such as knowledge, expertise, social and professional networks, and the ability to shape external environments to the firm's advantage [40]. Education, as highlighted by Hashim and Md Yusof [41] serves as a key indicator of an individual's competence, credibility, and depth of understanding. These attributes align closely with the tenets of the Resource Dependence Theory, suggesting that highly educated executives bring invaluable expertise and strategic capabilities to their organizations, thereby enhancing their capacity to implement effective CSR initiatives.

However, the impact of CEO education on CSR is not uniform. While some studies highlight the benefits of specialized education, such as MBA degrees, others suggest that broader educational backgrounds also contribute to CSR performance. For example, Ghardallou [42] found that CEOs with MBA or science-related degrees exhibit stronger CSR performance, particularly in industries requiring technical expertise. Conversely, Kutzschbach, et al. [43] reported a negative, albeit statistically insignificant, relationship between CEO business education and ESG performance, suggesting that non-business educational backgrounds may also yield positive CSR outcomes.

Based on the theoretical and empirical insights discussed above, the following hypotheses are proposed:

Hypothesis 1: CEOs with university education demonstrate superior CSR performance compared to those without such qualifications.

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Hypothesis 2: CEOs with postgraduate education demonstrate superior CSR performance compared to those without such qualifications.
Hypothesis 3: CEOs with business education (MBA or EMBA) demonstrate superior CSR performance compared to those without such qualifications.

2.4. R&D Investment Intensity and CSR

In today's competitive market environment, companies are increasingly recognizing the strategic importance of CSR in enhancing their reputation and addressing pressing social and environmental challenges [25, 44]. By adopting environmentally sustainable practices and engaging in community-oriented initiatives, firms aim to project a positive image and align with the expectations of diverse stakeholders. Signaling theory supports this approach, suggesting that a firm's commitment to CSR serves as a powerful signal of its integrity and responsibility, fostering trust and goodwill among stakeholders [6, 44]. This, in turn, enhances public interest in the organization and its leadership [17]. To meet evolving consumer demands and capture stakeholder attention, companies must innovate by developing environmentally friendly products, which often requires substantial investment in R&D.

2.4.1. The Role of R&D in Driving CSR

The manufacturing sector, particularly industries such as communication equipment, computers, and electronics, demonstrates a strong commitment to innovation through significant R&D investments. This focus is driven by dynamic environmental conditions, rising semiconductor prices, and increasing regulatory pressures to address global climate challenges [12]. Such investments underscore the strategic importance of R&D as a catalyst for technological advancements and sustainable solutions. Research highlights a strong correlation between R&D investment and CSR engagement. Companies that allocate substantial resources to R&D are often more committed to robust CSR activities, as these investments enable them to develop innovative products and processes that align with sustainability goals [15, 16]. Excluding R&D investment from econometric models analyzing CSR can lead to misspecification and inaccurate conclusions, given the well-established theoretical link between R&D and long-term economic performance [16]. This interplay underscores the need to integrate R&D investment into CSR research to gain a comprehensive understanding of corporate sustainability practices.

According to Wang, et al. [17] CSR investments enable firms to build deep and meaningful relationships with stakeholders. These relationships provide valuable insights that can enhance innovation capabilities and open new market opportunities. Many companies develop products or services that emphasize social responsibility, aiming to align with consumer preferences and cultivate a reputation for ethical practices. For instance, labels such as "organic" or "pesticide-free" not only reflect process innovations in sustainable farming but also introduce new product categories that appeal to socially conscious consumers [16]. This trend highlights the growing importance of integrating CSR elements into product development and marketing strategies.

Recent studies present mixed findings on the relationship between R&D investment intensity and CSR performance. Wang, et al. [17] found a significant negative relationship, suggesting that firms with higher R&D investments tend to achieve lower CSR outcomes. In contrast, Lys, et al. [15] observed a positive correlation between CSR expenditures and R&D investments among U.S. firms, indicating that greater CSR commitment can drive innovation.

Padgett and Galan [12] further reinforced the positive link between R&D and CSR, particularly in the manufacturing sector. Their study revealed that firms with a strong focus on R&D exhibit a heightened commitment to CSR, with manufacturing companies demonstrating a more pronounced impact. This underscores the critical role of R&D in driving CSR initiatives, especially in industries where innovation is central to sustainability efforts.

The Upper Echelons Theory posits that the personal attributes of CEOs, including their educational background, significantly influence organizational strategies, including R&D investment and CSR

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initiatives [45]. Highly educated CEOs are better equipped to process complex information, solve problems, and embrace innovative solutions, making them more likely to prioritize R&D investments [46]. However, Barker III and Mueller [45] found no significant impact of CEO education on R&D spending, suggesting that other factors may also play a role.

Despite these mixed findings, advanced education, particularly at the postgraduate level, is widely recognized for fostering innovative thinking and R&D capabilities. CEOs with advanced degrees are more likely to champion R&D initiatives, leveraging their cognitive complexity and problem-solving skills to drive organizational innovation [47]. Based on the theoretical and empirical insights discussed above, the following hypothesis is proposed:

Hypothesis 4: Companies with intensive R&D investment demonstrate superior performance in CSR.

3. Research Methodology

3.1. Research Model and Measurements

In order to assess the impact of CEOs' educational backgrounds and the intensity of R&D investment on CSR performance, three models were implemented:

Model (1):

$$CSR = \alpha_0 + \beta_1(uniedu)_{it} + \beta_2(RD\_inten)_{it} + \beta_3(sec\_Man)_{it} + \beta_4(Fsize)_{it} + \beta_5(Leverage)_{it} + \beta_6(Fage)_{it} + \mu_i + \varepsilon_{it}$$

Model (2):

$$CSR = \alpha_0 + \beta_1(postgrad)_{it} + \beta_2(RD\_inten)_{it} + \beta_3(sec\_Man)_{it} + \beta_4(Fsize)_{it} + \beta_5(Leverage)_{it} + \beta_6(Fage)_{it} + \mu_i + \varepsilon_{it}$$

Model (3):

$$CSR = \alpha_0 + \beta_1(CEObizedu)_{it} + \beta_2(RD\_inten)_{it} + \beta_3(sec\_Man)_{it} + \beta_4(Fsize)_{it} + \beta_5(Leverage)_{it} + \beta_6(Fage)_{it} + \mu_i + \varepsilon_{it}$$

Where, CSR = CSR performance, *uniedu* = CEOs' university education, *postgrad* = CEOs' postgraduate education (i.e. master and doctoral) , *CEObizedu* = CEOs' business education (i.e. MBA or EMBA), *RD_inten* = R&D investment intensity, *sec_Man* = Company type, *Fsize* = Comapny's size , *Leverage* = Company's leverage, *Fage* = Company's age. See Table 1 for variable definitions. The three models mentioned above were examined for both the manufacturing and service sectors, but without including the dummy variable "sec_Man".

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Table 1.
Variables Definitions and Measurements.

Variables	Acronym	Measurement
Corporate social responsibility performance	CSR	CSR Rating Score released by China Hexun.com
CEOs' university education	Uniedu	Dummy variable assumes the value 1 if the CEO has university education (i.e. , Undergrad, Master, Doctoral) , and 0 otherwise (i.e. technical secondary school and/or college).
CEOs' postgraduate education	Postgrad	Dummy variable assumes the value 1 if the CEO has master or doctoral, and 0 otherwise.
CEOs' business education	CEObizedu	Dummy variable assumes the value 1 if the CEO has MBA/EMBA, and 0 otherwise.
Research and Development investment intensity	RD_inten	Dummy variable assumes the value 1 if the company has intensive investment in R&D (i.e. more than the median of ratio of R&D investment to operating income*100), and 0 otherwise (i.e. equal to or less than the median of ratio of R&D investment to operating income*100).
Control Variables		
Company type	Sec_Man	Dummy variable assumes the value 1 if the company is listed under a manufacturing, and 0 for firms listed under services sectors. *Manufacturing sectors include:* Foodstuff manufacturing industry, Chemical feedstock and chemical manufacturing industry, Medicine manufacturing industry, Plastic industry, Non-ferrous smelting and extrusion, Metalwork industry, General-purpose equipment manufacturing industry, Specialized facility manufacturing industry, Manufacturing industry of communication equipment, computers, and other electronic equipment, and Electric machinery and equipment manufacturing industry. *Service sectors include*: Communication Services, Professional Services, and Retail trade
Firm's Size	Fsize	The natural logarithm of the total assets of the company at the end of the current period
Firm's Leverage	Leverage	The ratio of the company's total liabilities to total assets at the end of the current period
Firm's Age	Fage	Year of establishment

To conduct this study, data were collected from companies listed on the Shanghai and Shenzhen Stock Exchanges between 2015 and 2020, as utilized by Wang, et al. [17]. China, as the world's second-largest economy, has witnessed a significant increase in corporate transparency regarding sustainability and CSR practices. Between 2006 and 2015, the publication of CSR reports by Chinese firms surged by approximately 53%, reflecting a growing emphasis on sustainability within the country's financial landscape [10]. This trend has provided researchers with extensive opportunities to explore CSR activities and their communication within the Chinese capital market.

The study focused on companies operating in the manufacturing and service sectors, both of which are known for their substantial R&D activities. These firms were classified into manufacturing and service categories based on the guidelines established by the China Securities Regulatory Commission, as outlined by Wang, et al. [17]. Data on CSR performance were sourced from Hexun.com, a reputable platform for CSR evaluation in China, while additional financial and operational data were obtained from the CSMAR and CNRDS databases.

Hexun.com employs a comprehensive framework to assess the CSR performance of listed companies across five key dimensions: shareholders, employees, suppliers, customers, and the environment. This framework includes 13 secondary indicators and 37 tertiary indicators, providing a robust and detailed evaluation of CSR practices. According to Chen, et al. [48]. Hexun's scoring system offers a more

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reliable benchmark for CSR assessment compared to other databases, such as Rankins CSR Ratings (RKS). The Hexun CSR score is calculated using weighted proportions for each category: 30% for shareholders, 15% each for employees and suppliers, 20% for customers, and 20% for environmental and social performance. The maximum achievable score is 100, while companies with negative profit margins for shareholders may receive a negative score. This scoring system has been widely recognized and utilized in previous studies [10, 17, 49].

4. Results and Discussion

Table 2 presents an overview of the data collected from 1632 firm-year observations. The analysis reveals that a significant proportion of the companies within the study are engaged in manufacturing activities (70.71%), with the majority of them being led by CEOs holding university degrees (89.28%). Notably, over half of the CEOs in the sample possess advanced degrees (postgraduate), while those with business education such as an MBA or EMBA make up a smaller fraction at 9.07%.

Moreover, the data indicates a balanced distribution between manufacturing and service companies in terms of R&D investment intensity. Specifically, close to half of the companies exhibit high R&D investment intensity at 49.88%, while the remainder demonstrate low R&D investment intensity at 50.12%. This alignment underscores the strategic significance of R&D investment within both manufacturing and service sectors, emphasizing its pivotal role in driving innovation and sustainable business practices.

Table 2.
Descriptive of the Data Set

	Frequency	Percent	Cum.
Manufacturing companies	1154	70.71	70.71
Service companies	478	29.29	100
	1632		
Companies with high R&D investment intensity	814	49.88	49.88
Companies with low R&D investment intensity	814	50.12	100
	1632		
CEOs with university education	1457	89.28	89.28
CEOs with pre-university education	175	10.72	100
	1632		
CEOs with postgraduate education	877	53.74	53.74
CEOs with undergraduate and less education	755	46.26	100
	1632		
CEOs with business education	148	9.07	9.07
CEOs with no business education	1484	90.93	100
	1632		

Table 3 presents statistics of the continuous variable of the current study, revealing the mean, minimum, and maximum values of CSR performance exploration to be 22.324, -8.8, and 87, respectively. These findings demonstrate the varying levels of CSR performance among the sampled firms. Remarkably, the results differ from those of a study conducted by Chen, et al. [48]. Their research focused on A-share companies listed in China in 2019, and reported mean, minimum, and maximum values of CSR as 19.830, −4.120, and 35.760, respectively. Such disparities in CSR performance raise intriguing questions about potential influencing factors.

Notably, these outcomes are quite astonishing given that China is among the few countries that have explicitly mandated CSR through legislation. Furthermore, China stands out as the first nation to overtly incorporate the term "corporate social responsibility" into its corporate statute [50]. Consequently, the results of this study underscore the need to further investigate the determinants influencing companies' CSR performance.

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Table 3.
Descriptive Statistics of the Continuous Variables

Variables	Mean	S.D.	Minimum	Maximum
CSR	22.32405	12.58163	-8.8	87
Fsize	22.17632	1.070497	20.30574	25.96838
Leverage	0.3745605	0.167421	0.0496506	0.7848217
Fage	13.07721	5.244732	7	28

The findings presented in Table 4 reveal a positive correlation between CSR performance and several key variables, including CEOs' university education, postgraduate education, company size, and firm age. Conversely, CSR performance exhibits a negative correlation with R&D investment intensity, company type, and leverage. These results suggest that CEOs with higher levels of education are better equipped to lead sustainable and socially responsible initiatives, aligning with prior research [41, 51-53].

Larger firms, with their greater resources and organizational capacity, are more likely to engage in CSR activities, while firms with lower leverage may have the financial flexibility to prioritize such initiatives. As noted by Bhatia and Makkar [27] larger companies often disclose more extensive CSR-related information to mitigate political risks and build stakeholder trust. Additionally, the positive correlation between firm age and CSR performance indicates that mature companies are more likely to integrate CSR practices into their operations, reflecting a long-term commitment to sustainability.

Table 4.
Pairwise Correlation Coefficients Matrix

	CSR	Uniedu	postgrad	CEObizedu	RD_inten	sec_Man	Fsize	Leverage	Fage
CSR	1								
uniedu	0.0521**	1							
postgrad	0.1091***	0.3735***	1						
CEObizedu	0.0402	0.1094***	0.2930***	1					
RD_inten	-0.0756***	0.0843***	0.0948***	-0.0888***	1				
sec_Man	-0.0749***	-0.0533**	-0.0760***	0.0767***	-0.0123	1			
Fsize	0.2202***	0.1132***	0.0588**	-0.0103	-0.1631***	0.0016	1		
Leverage	-0.0929***	-0.0168	-0.0258	-0.0432*	-0.2572***	-0.0485*	0.5110*	1	
Fage	0.0591**	0.0693***	-0.0562**	-0.0221	-0.1126***	-0.0280	0.3578***	0.2354***	1

Note: * p<0.10, ** p<0.05, *** p<0.01

To ensure the reliability of the regression analysis, potential multicollinearity—a high correlation between independent variables that can distort results—was assessed using the Variance Inflation Factor (VIF). According to Hair, et al. [54] and Pallant [55] a VIF value exceeding 10 indicates significant multicollinearity. In this study, the VIF values ranged between 1.01 and 1.50, as shown in Table 5, well below the threshold. This confirms that multicollinearity is not a concern, thereby validating the robustness of the regression model.

Table 5.
Variance Inflation Factors (VIF) For Collinearity Test

	Model (1)	Model (2)	Model (3)
uniedu	1.03		
postgrad		1.03	
CEObizedu			1.02
RD_inten	1.08	1.08	1.09
sec_Man	1.01	1.01	1.01
Fsize	1.50	1.49	1.48
Leverage	1.43	1.42	1.43
Fage	1.16	1.16	1.16
Mean VIF	1.20	1.20	1.20

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To evaluate groupwise heteroskedasticity in the fixed effects model, the Modified Wald statistic, as proposed by Greene [56] was employed. The results of the heteroscedasticity test, presented in Table 6, indicate that all models significantly reject the null hypothesis of constant variance. This suggests the presence of heteroskedasticity in the dataset, implying that the variance of errors is not consistent across observations.

Table 6.
Modified Wald Statistic for Groupwise Heteroskedasticity

	Model (1)	**Model (2)**	**Model (3)**
chi2 (272)	46976.46	45743.52	45125.94
Prob>chi2	0.0000	0.0000	0.0000
Result	Hetro.	Hetro.	Hetro.

As shown in Table 7, the Wooldridge test results indicate the presence of autocorrelation across all evaluated models. To address this issue, robust estimation techniques, as recommended by Greene [56] were employed to ensure the reliability of the findings.

Table 7.
Wooldridge Test for Autocorrelation.

	Model (1)	**Model (2)**	**Model (3)**
F(1, 271)	34.354	33.992	33.412
Prob > F	0.0000	0.0000	0.0000
Result	Auto.	Auto.	Auto.

Panel data analysis offers significant advantages in research by capturing variations across both cross-sectional units and time periods. This approach minimizes temporal errors and enhances the generalizability of results [57]. The fixed effects model was utilized to estimate parameters for individual cross-sectional units (e.g., companies), while the random effects model incorporated random firm-specific terms to improve efficiency without requiring separate parameter estimation for each unit [58]. However, as Baltagi [58] notes, the random effects estimator may produce inconsistent results if fixed effects are correlated with independent variables.

To determine the most appropriate model, the Hausman specification test was conducted. The results, presented in Table 8, confirmed the suitability of the fixed effects model for this study [34, 57]. The findings derived from the fixed effects model were thoroughly analyzed to provide a robust and comprehensive understanding of the study's implications.

Table 8.
Hausman Specification Test

	Model (1)	**Model (2)**	**Model (3)**
chi2(5)	15.45	14.22	17.07
Prob>chi2	0.0086	0.0143	0.0044
Result	Fixed-effect	Fixed-effect	Fixed-effect

The examination of Model 1 and Model 3 in Table 9 reveals that the coefficients for CEO's university education (*uniedu*) and CEO's business education (*CEObizedu*) are positive but statistically insignificant. This suggests that these educational backgrounds may not significantly influence CSR performance across the sampled data. In contrast, the variable representing CEOs' postgraduate education (*postgrad*) shows a positive and statistically significant relationship at the 1% level. This indicates that CEOs with postgraduate degrees tend to achieve superior CSR performance compared to their counterparts without such advanced qualifications.

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These findings align with the Resource Dependence Theory, which posits that managers with advanced degrees, such as PhDs, serve as strategic assets for organizations. They bring a unique blend of competencies, expertise, and analytical capabilities that are critical for addressing complex issues like CSR [59-61]. Postgraduate education equips CEOs with specialized knowledge, advanced managerial skills, and the ability to generate innovative ideas, making them invaluable in shaping strategic policies and driving CSR initiatives [40, 62].

Additionally, the results support the Upper Echelons Theory, which suggests that organizations reflect the characteristics of their top executives [17, 33]. CEOs with postgraduate education are more likely to exhibit a strong commitment to CSR, leveraging their advanced expertise and decision-making capabilities to prioritize sustainability and social responsibility. This underscores the importance of considering advanced educational qualifications when selecting and developing top-level executives, as their leadership can significantly influence organizational outcomes.

Table 9.
Prais-Winsten regression, heteroskedastic panels corrected standard errors (General Model).

Variables	Model (1)	Model (2)	Model (3)
uniedu	1.482		
	(1.36)		
Postgrad		2.461***	
		(3.21)	
CEObizedu			1.834
			(1.30)
RD_inten	-2.333***	-2.442***	-2.204***
	(-3.53)	(-3.73)	(-3.34)
sec_Man	-2.557***	-2.405***	-2.691***
	(-2.92)	(-2.73)	(-3.08)
Fsize	5.007***	4.933***	5.067***
	(9.42)	(9.29)	(9.50)
Leverage	-20.70***	-20.60***	-20.74***
	(-8.12)	(-8.10)	(-8.15)
Fage	-0.110	-0.0871	-0.104
	(-1.22)	(-0.98)	(-1.17)
Year Dummies	Included	Included	Included
_cons	-73.67***	-72.43***	-73.86***
	(-6.78)	(-6.71)	(-6.78)
N	1632	1632	1632
R-sq	0.263	0.266	0.263
Wald chi2(11)	294.11	309.26	294.60
Prob > chi2	0.0000	0.0000	0.0000

Note: (1) z statistics in parentheses.
(2) * p<0.10, ** p<0.05, *** p<0.01.

To achieve the study's objectives, the influence of CEOs' educational backgrounds on CSR performance was examined separately for manufacturing and service companies. Separate regression analyses were conducted for each sector, addressing issues of heteroskedasticity and autocorrelation identified through the Modified Wald statistic and Wooldridge test, respectively. The Hausman specification test recommended the use of a random effects model for all models across both sectors, with the exception of Model 3 in Table 10 (CEO business education), for which a fixed effects model was deemed appropriate.

The results in Table 10 reveal that CEOs with postgraduate education and business education exhibit significantly positive coefficients, both significant at the 5% level. In contrast, R&D investment intensity maintains a consistently negative impact, significant at the 1% level. These findings align with those in Table 9 and further highlight the positive influence of CEO business education. Specifically,

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CEOs with postgraduate and business education outperform their peers in manufacturing companies, demonstrating a stronger commitment to CSR initiatives.

This aligns with prior research indicating that CEOs with advanced education are more likely to prioritize societal well-being and environmental sustainability [37]. Their educational background fosters values such as work ethic and social responsibility, which translate into more effective CSR strategies. Studies by Amore, et al. [38] and Malik, et al. [39] further confirm that CEOs with advanced degrees are more inclined to make environmentally conscious decisions and exhibit a heightened sense of social responsibility.

The significance of specialized education, such as MBA and Master of Science (MS) degrees, is underscored by studies such as Huang [63] and Woodruff [64]. These programs enhance CEOs' understanding of CSR-related issues, enabling them to drive better CSR performance within their organizations. For instance, Huang [63] found that CEOs with MBA or MS degrees demonstrate superior CSR outcomes, particularly in manufacturing firms. Similarly, Sannino, et al. [18] highlighted the heightened CSR perception among executives with MBA or science and engineering degrees, reflecting the broader impact of education on shaping CSR attitudes.

The study's findings emphasize the critical role of CEO education, particularly postgraduate and MBA/EMBA qualifications, in driving superior CSR performance within large manufacturing companies. CEOs with advanced educational backgrounds are better equipped to excel in CSR outcomes, especially in firms that are large, low-leveraged, and do not prioritize R&D investment. These insights underscore the importance of selecting and nurturing executives with advanced degrees to enhance corporate sustainability efforts.

Table 10.
Regression Analyses of Manufacturing Companies.

Variables	Model (1)	Model (2)	Model (3)
uniedu	1.000		
	(0.83)		
postgrad		2.382**	
		(2.55)	
CEObizedu			3.565**
			(2.20)
RD_inten	-2.847***	-2.944***	-1.850**
	(-3.14)	(-3.30)	(-2.51)
Fsize	3.251***	3.158***	4.871***
	(6.20)	(6.08)	(7.45)
Leverage	-23.37***	-23.03***	-21.99***
	(-7.19)	(-7.18)	(-7.49)
Fage	0.0295	0.0434	-0.0762
	(0.28)	(0.41)	(-0.74)
Year Dummies			Included
_cons	-41.57***	-40.11***	-73.34***
	(-3.85)	(-3.76)	(-5.48)
N	1154	1154	1154
R-sq			0.242
R-sq: within	0.0196	0.0205	
R-sq: between	0.2539	0.2720	
R-sq: overall	0.1251	0.1325	
Wald chi2(5)	66.69	76.58	
Wald chi2(10)			173.13
Prob > chi2	0.0000	0.0000	0.0000

Note: (1) z statistics in parentheses.
(2) * p<0.10, ** p<0.05, *** p<0.01
(3) Model 1 and 2: Random-effects GLS regression
(4) Model 3: Prais-Winsten regression, heteroskedastic panels corrected standard errors.

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The influence of CEOs' educational backgrounds and R&D investment intensity on CSR performance in service companies is presented in Table 11. The findings reveal trends that diverge from those observed in manufacturing firms (as shown in Table 10). Specifically, CEOs without business education (MBA/EMBA) demonstrate superior CSR performance in service companies with lower R&D investment intensity, while postgraduate education appears to have no significant impact. These results challenge existing literature and provide new insights into the role of CEO education in the service sector.

The findings contradict several studies, including Okechukwu Ugwuozor and Otu [65] who found a strong relationship between business ethics education and students' perceptions of CSR. Similarly, the argument by Sannino, et al. [18] that professional management education enhances administrative practices is not supported by this study. Furthermore, Bhattacharyya [66] reported that Indian MBA graduates positively influence organizations' adoption of environmentally friendly practices, which contrasts with the current findings. Additionally, Kutzschbach, et al. [43] found a negative, albeit insignificant, relationship between CEO business education and ESG performance, further complicating the narrative.

While business education provides theoretical knowledge of CSR and sustainability, translating these concepts into practical implementation within organizations remains challenging. Bridging the gap between ethical principles and operational strategies requires more than just a business education. CSR is a multifaceted and dynamic field that demands a deep understanding of social, environmental, and economic dimensions. CEOs with business education may lack the specialized expertise needed to address the complex issues inherent in CSR, particularly in the service sector. The study highlights the significant influence of external factors, such as stakeholder pressures, regulatory frameworks, and organizational values, on CSR performance in the service industry. These factors may outweigh the impact of CEOs' educational backgrounds, suggesting that the service sector's unique dynamics play a more critical role in shaping CSR outcomes than individual CEO attributes.

Table 11.
Regression Analyses for Service Companies.

Variables	Model (1)	Model (2)	Model (3)
uniedu	0.103 (0.04)		
postgrad		2.126 (1.17)	
CEObizedu			-6.900* (-1.91)
RD_inten	-4.305** (-2.24)	-4.513** (-2.39)	-4.657** (-2.52)
Fsize	2.907*** (3.00)	2.901*** (3.14)	2.927*** (3.01)
Leverage	-21.13*** (-3.40)	-21.34*** (-3.46)	-23.49*** (-3.82)
Fage	0.0337 (0.18)	0.0610 (0.33)	0.0265 (0.14)
_cons	-30.98 (-1.54)	-32.18* (-1.67)	-29.75 (-1.46)
N	478	478	478
R-sq: within	0.0098	0.0097	0.0148
R-sq: between	0.1725	0.1904	0.1784
R-sq: overall	0.0856	0.0924	0.0940
Wald chi2(5)	17.18	18.43	21.59
Prob > chi2	0.0042	0.0025	0.0006

Note: (1) z statistics in parentheses.
(2) * p<0.10, ** p<0.05, *** p<0.01
(3) Model 1, 2 and 3: Random-effects GLS regression.

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The study's findings reveal an intriguing observation regarding manufacturing and service companies with high R&D investment intensity. Companies that allocate fewer resources to R&D tend to outperform their high R&D counterparts in terms of CSR performance. This suggests that an excessive focus on R&D may divert attention and resources away from CSR initiatives, potentially creating conflicts with sustainability goals. In industries characterized by heavy innovation spending, the pursuit of cutting-edge technologies can sometimes lead to ethical, social, and environmental challenges. For instance, the development of advanced technologies may inadvertently result in negative environmental impacts or social concerns, such as data privacy issues or labor displacement. Additionally, high R&D investment often brings increased regulatory scrutiny, which can complicate the implementation of effective CSR strategies. These factors highlight the need for companies in R&D-intensive sectors to carefully balance innovation with social and environmental responsibility.

The findings underscore the importance of managing trade-offs between R&D investment and CSR performance. Companies must adopt a holistic approach that aligns innovation efforts with sustainability objectives, ensuring that technological advancements do not come at the expense of ethical and social considerations. By integrating CSR principles into R&D processes, firms can mitigate potential negative impacts and enhance their overall sustainability performance.

5. Theoretical and Practical Implications

The study contributes to the theoretical understanding of the relationship between CEO education and CSR performance by emphasizing the moderating role of organizational variables, such as R&D investment intensity. It highlights the complexity of this relationship and the need for a nuanced approach when examining CEO attributes.

From a practical perspective, the findings suggest that organizations should prioritize selecting and developing CEOs with advanced educational qualifications, particularly postgraduate degrees, to enhance CSR strategies. However, the sector-specific nature of these findings indicates that a "one-size-fits-all" approach is inadequate. Companies must align CEO educational backgrounds with the unique demands of their respective sectors.

6. Limitations and Future Research Directions

While this study provides valuable insights, it has certain limitations. The focus on CEO education and R&D investment intensity leaves room for exploring other CEO attributes, such as narcissism, age, and duality roles, which may further elucidate the relationship between CEO characteristics and CSR performance. Additionally, organizational variables like ownership structure—particularly in contexts with concentrated or state-owned enterprises—warrant further investigation. Future research should also consider the interplay between innovation, corporate governance, and CSR to provide a more comprehensive understanding of these dynamics.

7. Conclusion

The aim of this study is to investigate whether the educational background of CEOs has differing impacts on the CSR performance of manufacturing and service companies. Utilizing data from Chinese publicly listed companies, the study covers 1632 firm-year observations spanning from 2015 to 2020. Several panel models were employed to test the three developed hypotheses. The results of the general model indicate that low-intensive R&D investment companies in the service sector, led by postgraduate-educated CEOs, tend to outperform their counterparts in terms of CSR. However, upon separate examination of the two sectors, the conclusions differ. It is revealed that low-intensive R&D investment manufacturing companies outperform their peers only when their CEOs hold postgraduate and business qualifications. On the other hand, service companies excel when they exhibit low R&D investment intensity and are headed by CEOs without business education.

These findings emphasize the significance of CEO education in shaping organizational CSR practices. In light of CSR's increasing importance, organizations should prioritize selecting and

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developing CEOs with postgraduate education to enhance CSR strategies and implementation. These findings challenge the commonly held belief regarding the positive impact of MBA graduates in promoting and supporting CSR initiatives.

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