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DOES THE CHIEF EXECUTIVE OFFICER GREEN EXPERIENCE CONTRIBUTE TO THE LOW-CARBON TRANSITION OF THE ORGANISATION?

Abstract: From the perspective of chief executive officer (CEO) green experience, this paper delves into the catalysts propelling corporate transitions toward lower carbon footprints, empirically evaluating these factors using listed company data from 2011 to 2020. The study reveals that CEO green experience contributes to diminishing corporate carbon intensity, thereby fostering the shift towards lower carbon operations. Notably, this finding persists even after subjecting the analysis to robustness tests. However, the impact of CEO green experience, while promoting corporate low-carbon transitions, is comparatively lesser than other influential factors. This discrepancy exhibits distinct variations within the ownership structure and pollution attributes of companies. Specifically, the significance of CEO green experience is more pronounced in non-state-owned enterprises and heavily polluting firms.

Keywords: CEO green experience, low-carbon transition, ownership attributes, pollution attributes

Introduction

Presently, China stands amid a transition toward green initiatives, where the escalation of environmental regulations presents considerable challenges to high-polluting industries, amplifying their emission reduction costs. Therefore, it becomes imperative to embrace high-quality development by departing from the conventional model reliant on high energy consumption, extensive pollution, and high output. Instead, there is a pressing need to explore a more intensive and innovative low-carbon development framework, centered around the principles of energy conservation, environmental sustainability, and heightened efficiency. Recognising the realities of climate change and the imperative to shift towards green development, China, during the 75th UN General Assembly's general debate, declared its commitment to "enhance national autonomy, adopt more robust policies and measures, aim for peaking carbon dioxide emissions by 2030, and diligently strive for carbon neutrality by 2060".

The objectives - carbon peaking and carbon neutrality - constrain the micro-level low-carbon transformations, crucial for effectively realising emission reduction targets. Concurrently, the stringent environmental regulations backdrop has exacerbated carbon-related risks for enterprises during their production and operational phases. Strategies emphasising negative emission reduction and energy efficiency might further compound the risks associated with enterprise transformation [1-4]. This, in turn, could

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precipitate fluctuations in enterprise performance within the capital market, leading to unstable cash flows or even substantial reductions in financial assets, particularly affecting energy-intensive sectors such as materials, chemicals, and mining.

China's corporate trajectory is profoundly shaped by institutional influences, where the course of corporate low-carbon transformation is inevitably swayed by external mandatory institutional pressures [5, 6] or internal resource redundancies [7-9]. Nevertheless, pertinent studies have often overlooked the pivotal role of the CEO, the primary decision-maker in corporate low-carbon development. While a few studies have explored the influence of CEO gender on corporate environmental concerns [10-13], the impact of a CEO's accumulated experience - shaping thinking patterns, decision-making styles, and professional perceptions - far outweighs innate gender factors [14, 15]. Within this context, the issue of enterprise low-carbon transformation and development mirrors the cognitive stance of the CEO's corporate decision-making body towards environmental matters. Consequently, if the CEO possesses a background or experience in "green" education, it undeniably heightens their attention to sustainable development issues, enabling a clearer recognition of the significance of low-carbon development and transformation for the enterprise's long-term growth.

This paper aims to elucidate the significant influence of CEOs' prior green experience on Chinese A-share listed companies' decisions to transition towards low-carbon practices in Shanghai and Shenzhen. By combining theoretical analysis with empirical evaluation, our research focuses on quantifying the specific impact of CEO green experience on corporate carbon emission levels, thereby shedding light on the role of leadership in driving sustainable transitions within enterprises.

Literature review

The aim of enterprise low-carbon transformative development is to reduce energy consumption and minimise carbon emissions through technological and procedural innovations [16, 17], thereby enhancing enterprises' green competitiveness within a high-quality developmental market environment. Advanced theoretical inquiries underscore the significant impact of individual characteristics of corporate executives on organisational behavioural choices. For instance, Kassinis et al. [18] noted that female executives, as opposed to their male counterparts, typically demonstrate heightened concern regarding environmental issues, thereby directing more attention toward the green transformation of corporate development. Similarly, Galbreath [19] suggested that companies with a higher proportion of female executives exhibit a relatively stronger inclination toward corporate green transformation.

Furthermore, the influence of corporate executives on organisational behavioural decision-making extends beyond inherent characteristics such as gender. Their decision-making inclinations are significantly shaped by personal experiences or circumstances, with disparities in individual experiences often resulting in selective cognition and decision-making biases. Consequently, these discrepancies contribute to significant variations in corporate development strategies.

Upper Echelons Theory often adopts a generalised approach toward corporate executives, treating managers across various levels and roles as a unified entity without meticulous differentiation between CEOs and senior executives. However, the influence of different executive roles on corporate decisions exhibits noticeable imbalances as

executives of varying positions do not wield equal decision-making authority within the organisation [20, 21]. Given that the CEO serves as the top leader of the enterprise, their decision-making influence significantly surpasses that of ordinary corporate executives. Failure to recognise this distinction might lead to an underestimation of individual CEOs' impact on enterprise development.

Consequently, recent research has shifted its focus to scrutinising the impact of individual CEO characteristics on corporate development strategies, with a specific emphasis on CEO experiences. These studies have explored diverse dimensions of CEO experiences, encompassing financial, poverty, overseas, and academic backgrounds. Despite the richness in research concerning CEO experiences, scant attention has been paid to the specific realm of CEOs' green experiences, which serves as the focal point of this paper. Given that decisions related to corporate low-carbon development fundamentally reflect managers' stances toward environmental concerns, CEOs' green experiences inherently intertwine with corporate low-carbon development. In light of this, this paper regards CEO green experiences as an intrinsic driver of corporate low-carbon transition, aiming to empirically examine its quantitative association.

Research hypotheses

The Upper Echelons Theory posits that disparities in educational backgrounds, professional experiences, and work environments engender distinct individual traits. These traits subtly influence a manager's personal values and attention inclinations, sculpting specific cognitive patterns when evaluating and resolving issues, thus guiding behavioural decisions with unique individual preferences. Simultaneously, deeply ingrained personal traits shape solutions, enabling managers to consistently manifest their behavioural tendencies or evolve cognitive inclinations through relevant experiences.

Within the framework of the CEO's environmental acumen, green-related traits wield substantial influence on the CEO's emphasis on environmental concerns, particularly within the current era marked by carbon peaking and carbon-neutral emission reduction objectives. The cognitive and behavioural tendencies arising from a CEO's environmental expertise significantly bolster the development of low-carbon transformation within enterprises. This paper contends that the influence of CEO green experience on the advancement of enterprise low-carbon transition primarily emanates from two pivotal aspects:

- Firstly, the CEO's green experience amplifies the enterprise's focus on low-carbon transition, thereby enhancing the allocation of resources for the enterprise's low-carbon transition endeavours. The CEO's attention plays a pivotal role in guiding organisational management and innovation [22]. CEOs with environmental expertise tend to uphold high ethical standards in environmental protection, actively assuming social and environmental responsibility, and maintaining continuous vigilance over low-carbon environmental issues. Evident in corporate decision-making, CEOs with green experience exhibit heightened awareness of and conviction in the significance of low-carbon transition activities for the enterprise's long-term development. Despite potential short-term earnings risks, such CEOs allocate more resources to low-carbon transition initiatives, expediting research and development efforts in low-carbon technological innovations, thereby bolstering support for the enterprise's low-carbon transition.

- Secondly, the CEO's green experience enriches their mastery of ecological and environmental protection information, consequently enhancing the efficiency of the enterprise's low-carbon transition. Amidst the backdrop of high-quality development, enterprises face mounting environmental pressures stemming from diverse stakeholder demands. Governmental bodies compel green production through stringent environmental regulations and incentive mechanisms, while institutional investors oversee positive environmental behaviours for long-term income prospects. Simultaneously, consumers demand greener product designs [23]. Confronted with escalating pressure for low-carbon transition, enterprises resort to strategic adaptation and substantive enhancements. While some may opt for superficial environmental actions to minimise compliance costs, substantial improvements not only augment the environmental legitimacy of the enterprise but also enhance its market competitiveness. The crux of behavioural choices for low-carbon transition hinges on the enterprise's resources and information acquisition capabilities. When an enterprise's CEO possesses green experience, their wealth of environmental knowledge and development expertise aids in accurately identifying the foundation for low-carbon transition development, enabling swift formulation of low-carbon transition strategies, thereby significantly boosting the efficiency of low-carbon transition efforts.

Consequently, this paper advances a research hypothesis: CEO green experience significantly contributes to the low-carbon transition of companies.

Methods

Data sources

This study is grounded in panel data derived from A-share listed companies in Shanghai and Shenzhen spanning from 2011 to 2020. To ensure data reliability, financial listed companies, those classified as "ST" during the sample period, and companies with significant data gaps were excluded. Moreover, in an endeavour to mitigate the influence of outliers on estimation results, the sample data underwent refinement at the 1 % threshold. As a result, the study culled a total of 14,092 observations. Energy consumption data pertaining to listed companies primarily originates from corporate annual reports, while data concerning CEO green experience and other individual characteristics are sourced from the CSMAR database. Additionally, relevant corporate financial data predominantly derive from the Wind database.

Model design

This paper constructs the following benchmark regression model:

$$CF_{it} = \alpha_0 + \alpha_1 CEO_{it} + \alpha_2 X + \nu_i + \lambda_t + \varepsilon_{it} \quad (1)$$

where i denotes an individual enterprise and t - a year; CF_{it} - the level of low-carbon development of enterprise i in year t , and CEO_{it} - whether the CEO of enterprise i in year t has green experience; α_0 - the constant term, and α_1 and α_2 denote regression coefficients, respectively; X - control variables; ν_i - firm fixed effects and λ_t represents time fixed effects, respectively. The variables of interest are specified as described below.

- (1) The assessment of enterprise low-carbon development (CF) aims to mitigate the influence of enterprise scale on carbon emissions. This paper employs carbon intensity,

- characterised by the ratio of total enterprise carbon emissions to main business income, as a measure of the enterprises' low-carbon development level. The calculation of total enterprise carbon emissions primarily relies on estimates derived from energy consumption data disclosed in the companies' annual reports.
- (2) The evaluation of CEO green experience (*CEO*) involves analysing the biographical data of listed company executives. This examination confirms whether the CEO engages in work experiences related to environmental sustainability. The construction of the CEO green experience 01 dummy variable involves assigning a value of 1 if the CEO has green experience and 0 otherwise. Specifically, green education is determined based on the major, encompassing fields like, environmental studies, environmental engineering, and related disciplines. Green work experience involves roles or affiliations with entities such as leadership positions in corporate pollution prevention, among others.
- (3) Control variables: enterprise size (*Size*), indicated by the logarithm of the number of employees; enterprise age (*Age*), calculated as the current year minus the enterprise's establishment year plus 1; (*Leverage*), represented by the ratio of total liabilities to total assets; liquidity (*Liquid*), depicted by the ratio of current assets to total assets; high-tech attributes (*Hte*), distinguished by labeling high-tech enterprises as 1 and others as 0; ownership attributes (*Nature*), categorising state-owned enterprises as 1 and non-state-owned enterprises as 0; return on total assets (*Roa*), measured by the ratio of net profit to total assets. Descriptive statistics for the pertinent variables are presented in Table 1.

Table 1

Descriptive statistics

Variable	Obs	Mean	SD*	Maximum	Minimum
<i>CF</i>	14092	1.30	0.90	4.51	0.24
<i>CEO</i>	14092	0.96	1.52	1.00	0.00
<i>Size</i>	14092	5.12	4.38	5.97	1.95
<i>Age</i>	14092	2.71	1.64	4.13	0.00
<i>Leverage</i>	14092	0.40	0.20	1.65	0.01
<i>Nature</i>	14092	0.06	0.08	0.51	-3.98
<i>Hte</i>	14092	0.13	0.17	1.35	-0.58
<i>Roa</i>	14092	3.99	2.72	4.57	2.25
<i>Liquid</i>	14092	4.91	5.37	8.98	0.00

*SD - standard deviation

Empirical results

Benchmark regression analysis

Table 2 delineates the influence of CEO green experience on corporations' transition toward low-carbon practices. Model (1) excludes control variables, whereas Model (2) disregards firm fixed effects and time fixed effects, and Model (3) introduces control variables, firm fixed effects, and time fixed effects concurrently. The outcomes consistently reveal negative regression coefficients for CEO green experience impacting the carbon intensity of the manufacturing sector. These coefficients display statistical significance at a 1% confidence level, signifying that CEO green experience contributes to carbon intensity

reduction, thus corroborating the hypotheses posited in this paper. Importantly, these findings persist even subsequent to the integration of the pertinent set of control variables.

Employing quantile regression, this study transcends the average viewpoint offered by ordinary least squares. This approach facilitates the estimation of the conditional distribution of corporate carbon intensity, facilitating a nuanced comprehension of CEO impacts across diverse quartile groups. The analysis is stratified into quartiles at 0.25 (q-0.25), 0.50, and 0.75 in Model (4). The results unveil heterogeneous impacts of CEO green experience on corporations' carbon intensity at different quantile values. High carbon intensity corporations are notably more influenced by CEO green experience, while its significance wanes in low carbon intensity corporations. Overall, CEO green experience emerges as a beneficial catalyst for corporations' transition toward low-carbon practices.

Table 2 posits that the positive effect of CEO green experience emanates from CEOs' heightened focus on environmental concerns, leading to augmented green investments and facilitating low-carbon transformation. Furthermore, CEOs with green experience harbour specialised knowledge advantages in low-carbon development, enabling expedited formulation of strategies that expedite corporations' low-carbon transition.

Table 2

The benchmark regression analysis

Variable	Model (1)	Model (2)	Model (3)	Model (4)		
				q-0.25	q-0.50	q-0.75
<i>CEO</i>	-0.0893*** (-3.77)	-0.0846 (-3.60)	-0.0731* (-3.65)	-0.1185 (-1.50)	-0.0770*** (-2.89)	-0.0977*** (-3.79)
<i>Insize</i>		-0.0052*** (-6.11)	-0.0038*** (-4.99)	-0.0034*** (4.51)	-0.0041*** (-4.28)	-0.0026** (-2.03)
<i>Age</i>		-0.2516** (-2.04)	-0.1842*** (-2.91)	-0.2527** (-2.31)	-0.2721** (-1.98)	-0.1126*** (-2.78)
<i>Leverage</i>		-0.0225 (-1.37)	-0.0437 (-1.04)	-0.0084 (-1.29)	-0.0039 (-1.41)	-0.0305 (-1.37)
<i>Nature</i>		0.0069*** (3.32)	-0.0041** (-2.14)	-0.0015 (-0.80)	-0.0005 (-0.24)	-0.0021 (-0.68)
<i>Hte</i>		-0.0263 (-0.41)	-0.0500 (-0.56)	-0.0771 (-0.69)	-0.0470 (-1.04)	-0.0787 (-2.88)
<i>Roa</i>		0.0166* (1.92)	0.0098 (1.27)	0.0002 (0.04)	0.0144 (-0.14)	0.0174 (1.33)
<i>Liquid</i>		-0.00001 (-0.44)	-0.00001 (-0.07)	0.00001 (0.13)	-0.00001 (-0.14)	-0.00001 (-0.33)
Firm-fixed effect	YES	NO	YES	YES	YES	YES
Time-fixed effect	YES	NO	YES	YES	YES	YES
Obs	14092	14092	14092	14092	14092	14092
R^2	0.2146	0.2205	0.2564	0.1900	0.2406	0.1539

Note: ***, ** and * represent the significance levels of 1 %, 5 % and 10 % respectively; The value of t is in brackets. R^2 represents the goodness-of-fit of the model and is equal to the ratio of the sum of squares of regression to the sum of squares of total deviations

Robustness analysis

Table 3 illustrates the examination of green education-related experience (*CEO_edu*) and green work-related experience (*CEO_work*) on enterprises' low-carbon transition, showcased in columns (1) and (2) respectively. Notably, both types of experiences demonstrate a capacity to diminish enterprises' carbon intensity, affirming their role in fostering low-carbon transition and lending credibility to the earlier conclusions.

Furthermore, the bidirectional causality between CEO environmental expertise and the advancement of low-carbon transitions within corporations may engender endogeneity. This arises from the reciprocal relationship wherein CEO environmental expertise fosters corporate low-carbon transitions while also being influenced by the progress of corporate low-carbon development. Essentially, enhanced environmental performance by a corporation may lead to a proclivity for recruiting CEOs with environmental expertise. To counteract endogeneity concerns, this study employs the average value of CEO environmental expertise from peer corporations within the same sector with a lag of one period as an instrumental variable. This instrumental variable methodology is examined utilising the two-stage least squares technique, delineated in columns (3) and (4) of Table 3.

The results from the initial stage indicate a significant correlation between the instrumental variables and the environmental expertise of CEOs within corporations. Subsequent estimation outcomes from the second stage, subsequent to addressing potential endogeneity issues, confirm that CEO environmental expertise continues to be a noteworthy driver of the substantial decline in corporate carbon intensity. This reaffirms its crucial role in fostering the transition of enterprises toward low-carbon practices, even subsequent to mitigating potential endogeneity concerns through instrumental variable analysis.

Table 3

The Robustness test results

Variable	Replace explanatory variables		Instrumental variable	
	Model (1)	Model (2)	Model (3)	Model (4)
<i>CEO</i>	-0.0794*** (-3.10)	-0.0729*** (-2.85)		-0.4582*** (-2.98)
<i>L. CEO</i>			1.0288*** (5.00)	
CV	YES	YES	YES	
Firm-fixed effect	YES	YES	YES	
Time-fixed effect	YES	YES	YES	
Hansen J P-value			0.908 (0.41)	
Cragg-Donald Wald F-value			28.33	
Stock-Yogo10 % critical value			5.17	
Obs	14092	14092	14092	
R^2	0.1288	0.1689	0.4126	

Heterogeneity analysis

The study delves into whether there are differentiated impacts of CEO green experience on enterprises' carbon intensity, exploring these effects based on ownership attributes and pollution attributes.

- (1) Ownership dimension: The findings presented in columns (1) and (2) of Table 4 underscore the notable influence of CEO green experience in promoting low-carbon development within non-state-owned enterprises. This suggests that in these contexts, the presence of CEOs with green expertise significantly contributes to advancing sustainability agendas and facilitating the transition towards environmentally responsible business practices.

State-owned enterprises often enjoy distinct advantages stemming from their political affiliations, access to resources, and preferential policy support. These entities operate within more favourable external environments and possess larger scales, which afford them

significant leverage in pursuing low-carbon transformation initiatives. Given their robust financial standing, State-owned enterprises can readily commit substantial upfront capital investments towards such endeavours. CEOs within state-owned enterprises typically operate under the influence of government bodies, with decision-making often guided by administrative considerations. In the context of carbon peak and neutrality imperatives, these enterprises align their strategic directives with local government low-carbon policies, positioning themselves as trailblazers in the transition towards a low-carbon economy.

Conversely, non-state-owned enterprises encounter greater challenges in accessing financing due to heightened operational uncertainties. CEOs with green experience in these enterprises play a pivotal role in bolstering investor confidence, thereby attracting more substantial financial backing to alleviate financing constraints. Additionally, their leadership can more effectively drive low-carbon transition efforts owing to their enhanced autonomy in decision-making processes.

(2) Pollution attribute dimension:

The analysis in columns (3) and (4) of Table 4 underscores the importance of CEO green experience in promoting low-carbon development across different industry contexts. It suggests that the impact of CEO green experience is more pronounced in industries where environmental concerns may not be as pressing, highlighting the potential for proactive leadership to drive sustainability efforts even in sectors with lower inherent environmental risks. In essence, the findings imply that while external pressures certainly influence the adoption of low-carbon practices, the role of CEO green experience remains significant in shaping organisational strategies and driving sustainability initiatives, particularly in industries where environmental considerations may not be as prominent.

Heavily polluting industries are under considerable scrutiny due to their environmental impact, facing stringent regulations and heightened public scrutiny. As a result, there's a strong imperative for them to pursue low-carbon transformation and green innovation. In such sectors, the pressure to reduce carbon emissions is often a top priority, and CEOs may prioritise this aspect over other considerations, potentially diminishing their reliance on CEO green experience alone. On the other hand, industries with lower pollution levels may have less external pressure to adopt low-carbon practices. In these cases, CEOs with green experience can play a significant role in driving attention towards sustainability initiatives and accelerating the transition to low-carbon operations. Their expertise and advocacy can lead to the formulation of effective strategies tailored to the specific challenges and opportunities in these industries.

Table 4

The heterogeneity analysis

Variable	Model (1)	Model (2)	Model (3)	Model (4)
	State-owned enterprise	Non-state-owned enterprises	Heavy pollution type	Non-heavy pollution type
CEO	-0.0478*** (-2.90)	-0.0816*** (-3.20)	-0.0610*** (-2.78)	-0.0872*** (-3.46)
CV	YES	YES	YES	YES
Firm-fixed effect	YES	YES	YES	YES
Time-fixed effect	YES	YES	YES	YES
Obs	6813	7279	5594	8498
R ²	0.1575	0.2167	0.1940	0.1951

Conclusion and policy recommendations

The study focusing on carbon peak and neutrality goals reveals crucial insights into the factors influencing enterprise low-carbon transformation. Chief among these findings is the significant impact of CEO green experience in reducing enterprise carbon intensity, underscoring their positive contribution to low-carbon initiatives. These conclusions are robust, with empirical evidence supporting their validity even after rigorous testing. Furthermore, the study identifies heterogeneity in the impact of corporate low-carbon transition, particularly noting its amplified effect within non-state-owned enterprises and non-polluting industries.

Building upon these findings, the paper offers recommendations aimed at fostering low-carbon enterprise transformation. Firstly, it emphasises the importance of CEO qualities in driving this transformation, suggesting that government departments promote green development in college specialties to cultivate talent with green educational experience. Additionally, the paper advocates for enhancing the green professional knowledge and skills of market managers, enabling them to effectively support environmentally conscious enterprises. Secondly, the paper underscores the need for individual development among enterprise managers, urging them to prioritise enhancing their own green professionalism through education, training, or work experience accumulation. This approach enables active participation in low-carbon development initiatives within their respective enterprises.

However, it's important to acknowledge several limitations and avenues for future research. One limitation is the potential for sample bias, as the study may have focused predominantly on certain industries or regions, limiting the generalisability of findings to broader contexts. Additionally, while the study identifies heterogeneity in the impact of corporate low-carbon transition, further exploration into the underlying mechanisms driving these variations could provide deeper insights. Moreover, the recommendations provided in the paper offer valuable insights into fostering low-carbon enterprise transformation. However, future research could delve into the effectiveness of these recommendations in different organisational contexts and cultural settings. Additionally, exploring alternative strategies for incentivising and supporting green initiatives within enterprises could enrich our understanding of effective approaches to promote sustainability.

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