Causality of Internal and External Linkages of Enterprises' Low-Carbon Strategy From a Configuration Perspective

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Research Article

Keywords: Business environment, industry environment, individual heterogeneity, corporate low-carbon strategy, qualitative comparative analysis of fuzzy sets

Posted Date: October 19th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-867423/v1>

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Abstract

This study aims to identify the motivations behind the low-carbon strategy of companies. For this purpose, a fuzzy set qualitative comparative analysis is conducted to explore the linkage effects of internal and external factors such as business environment, industry environment and individual heterogeneity on the company's low-carbon strategy based on a multi-dimensional theoretical perspective. It is found that the low-carbon strategy of companies in a low, medium, and high-level business environment follow the order of "survival maintenance", "firm foothold", "bigger and stronger", "adapt to the trend", and "value innovation". Further analysis shows that the proper order of the three types of indicators from high to low is: industry environment, individual heterogeneity, and business environment. "The industry is under pressure and has enough power" is a key reason for low-carbon strategies; the competition intensity within the industry is an important external incentive for low-carbon strategy; CEO power is an important internal driving force for low-carbon strategy. This paper shows that a high-level business environment can help to improve managers' forward-looking decision-making and help companies escape the inherent thinking of the "red sea competition".

1 Introduction

On September 22, 2020, at the United Nations General Assembly, President Xi Jinping announced that "stronger policies and measures will be adopted, and carbon dioxide emissions will strive to reach the peak before 2030, and strive to achieve carbon neutrality by 2060." In 2021, the Central Economic Working Conference determined "do a good job in carbon peaking and carbon neutrality" as one of eight key tasks. Industrial enterprises are the main sources of carbon dioxide emissions (Zhang et al. 2012). Helping industrial enterprises to achieve low-carbon development under low-carbon strategy would also help to achieve the goals of "carbon peak" and "carbon neutrality" as outlined by Xi Jinping. Existing studies show that low-carbon strategy of industrial enterprises are affected by many factors, including the technological innovation level of the enterprise or industry, the size of the enterprise and the management ability, consumption, and the influence of external factors (e.g., entrepreneurs and corporate business environment). However, the academic community has not identified a consistent set of motivations of enterprises' low-carbon strategy (Guo and Zhu 2021).

Most studies used the theory of environmental economics and enterprise heterogeneity to explain the low-carbon strategy of enterprises (Soytas et al. 2007; Ru et al. 2010). The core theoretical perspective of environmental economics is the use of economic means for environmental management. Examples of such means are tax incentives, environmental trading rights, pollution fines and other measures, all of which emphasize environmental regulatory factors that affect the choice of low-carbon strategy of enterprises (Wang et al. 2019). However, the conclusions are inconsistent. A number of scholars conclude that environmental regulatory policies can promote the implementation of low-carbon strategy of enterprises (Battisti 2008; Luken and Rompaey 2008). However, overly harsh environmental regulation policies would increase the costs of enterprises, which may affect their choice of low-carbon strategy (Peng et al. 2021). Others point out that the external environment is not significantly related to the low-

carbon strategy of enterprises (Jiang et al. 2020). Enterprises would actively implement low-carbon strategy to improve their business environment, and even exceed local environmental protection standards in consideration of sustainable development (Khanna 2001). However, most of the studies under environmental economics assume that enterprises are homogeneous, failing to further explore the low-carbon strategy of enterprises from the perspective of heterogeneity. From enterprise heterogeneity perspective, managers' perceptions of low-carbon environmental protection, corporate characteristics, and transformational leadership behaviors are important influencing factors of low-carbon strategy (Zhang et al. 2012; Nishitani et al. 2011). However, some still believe that seeking the optimal balance between revenue growth and carbon emission reduction is the basic point for enterprises to implement low-carbon strategy, although their motives are different (Guo and Zhu 2021; Shin et al. 2008).

In summary, there is no consensus explanation for enterprises' low-carbon strategy from the above two perspectives. This is because the antecedent conditions for the choice of a low-carbon strategy are not independent. The interactive feedback of macro and micro elements would form a complex causal relationship for the choice of a low-carbon strategy. Therefore, a theoretical framework based on a multi-dimensional perspective would be helpful to further explore the interactions between different influencing factors. Such a framework is extremely necessary for understanding the low-carbon strategy of enterprises.

This paper integrates environmental economics and enterprise heterogeneity theory, and uses the configuration theory to study multi-factor concurrent complex causality of enterprises' low-carbon strategy choice. For this work, 669 listed companies in 16 heavy-polluting industries at Shanghai and Shenzhen stock markets from 2010 to 2017 were screened. Using the fuzzy set qualitative comparative analysis method, the configuration of low-carbon strategy choices was analyzed, and eight different groups were identified. The state of affairs can trigger the implementation of a company's low-carbon strategy.

Marginal contributions of this paper are as follows: First, a multi-theoretical perspective of the low-carbon strategy selection framework is constructed. By simulating the overall internal and external environment of enterprise operation, this paper studies the choice of enterprises' low-carbon strategy, expanding the answer of the existing research to this problem. Second, this paper provides a new perspective and evidence for alleviating the enduring contradictions in the studies of enterprises' low-carbon strategy. Existing research on enterprises' low-carbon strategy tends to emphasize the role of single factors (e.g., environmental regulations, consumer attributes, and corporate individual heterogeneous behavior), failing to analyze their interactive relationship in depth. Exploring the net effect of a single factor in isolation may lead to more contradictions. This paper provides a new explanation for this problem from a perspective of configuration. The key is how different elements match and interact between different conditions. Third, this paper uses the large-sample fuzzy set qualitative comparative analysis method to explore the complex causality that affects the choice of low-carbon strategy of enterprises, which can fill in the gaps of previous research to some extent.

The remainder of the study is structured as follows: Sect. 2 presents a review of relevant literature and the theoretical framework. Section 3 describes the research design. Section 4 reports and discusses the

estimation results, and Sect. 5 draws the main conclusions.

2 Literature Review And Theoretical Framework

2.1 Literature review

The British energy white paper “The Future of Our Energy: Creating a Low-Carbon Economy” in 2003 proposed a low-carbon economy. Since then, enterprises’ low-carbon strategies have gradually become the focus of studies. Existing literature can be divided into two different levels: macro environment and enterprise heterogeneity.

2.1.1 The perspective of environmental economics

Related research from the perspective of environmental economics suggests that low-carbon strategy can help enterprises avoid additional costs under environmental supervision (Khanna et al.2010). Under the environmental supervision, enterprises often adopt a safer low-carbon strategy to "protect themselves" in order to establish the corporate image and "learn" the low-carbon measures of competitors. A large number of literature shows that environmental supervision exerts a significant macro-guidance effect on the low-carbon strategy of enterprises (Chen et al.2006). Earlier studies show that external effects such as government regulations have a positive effect on enterprises’ emission reduction strategies (Montalvo 2002). Recent studies further argue that enterprises have become increasingly active in implementing low-carbon strategies under the increasingly improved environmental regulations. Moreover, the low-carbon practices of industry leaders would also guide the choice of active low-carbon strategy of small and medium-sized enterprises (Wakeford et al.2017).

However, doubts about previous studies have gradually increased with the gradual improvement of environmental regulations. Some studies argue that the external environment has no significant influence on the green innovation strategy of enterprises (Singjai et al. 2018). Some claim that the government’s guiding policies for green development may have a "crowding out" effect (González et al. 2012;Park 2015). Enterprises are likely to reduce and rely on their own green investment due to low-carbon innovation subsidies or tax incentives. The reason for this contradictory conclusion is that the effects of regional environmental supervision are full of uncertainty. Enterprises’ response to the regulatory system is not exogenous and is restricted by other laws and regulations, peer performance and other conditions (Tang et al. 2016). Therefore, it is impossible to make a reasonable explanation for this problem from the perspective of one or several types of macro environment.

2.1.2 The perspective of enterprise heterogeneity

Enterprises are likely to make favorable development decisions under the multiple pressures generated by the government and the market (Delmas and Toffel 2008). However, the heterogeneous choices of enterprises under the same system could be explained from the perspective of enterprise heterogeneity. This kind of research is relatively limited, and the existing literature can be divided into two categories. One

is how does the internal characteristics of enterprises produce low-carbon strategy, such as manager characteristics, and whether products are directly oriented to consumers. The other one is the impact of enterprises' low-carbon behavior, such as the impact of low-carbon strategy on carbon performance and enterprise value. It is shown that the implementation time and intensity of enterprises' environmental management behavior are significantly affected by managers' attitude (Luken and Rompaey 2008). Low-carbon development is positively related to the competitive advantage of enterprises, and from this, enterprises yield more motivation for low-carbon development through organizational learning (Tu and Wu 2020). However, others present a different view. They assume that the strategy of an enterprise is not simply related to the power of the CEO or the low-carbon awareness or learning ability of the management team, but also affected by the organizational learning ability under different environmental regulatory systems.

2.1.3 The combined perspective of environmental economics and enterprise heterogeneity

Recently, as a more reasonable explanation of reality, the interactive influence of macro and micro factors on the low-carbon strategy of enterprises has gradually become a research focus and has been demonstrated and supported. Compared with the single motivation, the mixed motivation of interest driven and ethics orientation are more likely to promote green innovation behavior of enterprises. Differences exist in the focus of mixed motivations when enterprises respond to different institutional pressures (Mair et al. 2016). In addition to interest and ethical motivation, the technological progress of the industry and the economic subsidies that enterprises can obtain would also provide sufficient feasible motivation for enterprises to improve their efficiency of re-allocating resources when absorbing new technologies (Yang et al. 2015). Therefore, considering enterprises' low-carbon strategy from the perspective of internal and external mixed motivations of environmental ethics and strategic flexibility, it is helpful to examine the existing controversies and blind spots in existing research. Existing research still fails to consider the complexity of the external environment of companies and the complex causality of the implementation of companies' low-carbon strategies. The interactive relationship between various influencing factors has not received sufficient attention.

Therefore, this paper simulates the overall external environment of business operations in the business environment to address the following key questions: What kind of configuration of the business environment does the coupling of elements of the business environment constitute in different regions? How are the internal conditions that guide enterprises' low-carbon strategy under different business environments constituted?

2.2 Theoretical framework

2.2.1 Individual heterogeneity and enterprises' low-carbon strategy

Individual heterogeneity can provide more theoretical evidence for the differentiated choice of low-carbon strategy under the same institutional environment. Existing literature has explored the internal factors that influence the low-carbon strategy of enterprises from the perspectives of the characteristics of decision-makers, the heterogeneity of the senior management team, the enterprise attributes, and enterprise scale. Among these, the stronger the low-carbon awareness of managers, the easier for them to produce low-carbon strategies. The senior management team and the nature of the company also affect the implementation of emission reduction strategies. The current micro-environmental factors that affect enterprises' low-carbon strategy can be roughly classified into organizational characteristics (e.g., enterprises scale and enterprises nature), characteristics of decision-makers (e.g., professional background and whether they hold equity), and characteristics of senior management teams (e.g., age, gender, and professional background).

2.2.2 Business environment and enterprises' low-carbon strategy

The business environment mainly contains all external environments a company faces at its main location (Furnari et al. 2020). Existing studies have shown that the quality of the business environment directly affects the formulation of enterprise strategies (Li 2019). The factors of the business environment are therefore an important institutional prerequisite for the business ecology (Dominic et al. 2010), which determines whether an enterprise can obtain sufficient human, financial, material, and key elements (e.g., social capital and intellectual property rights support the implementation of various strategies of the enterprise). Therefore, based on the concept of corporate strategic transformation, rather than analyzing the important role of one or several business environment elements in the formulation of enterprises' low-carbon strategy (as was applied by most other studies), this paper simulates the real internal and external environment of business operations.

2.2.3 Industry environment and enterprises' low-carbon strategy

The industry environment mainly represents the degree of competitiveness and heterogeneity of the business environment of an enterprise in its industry (Dess and Beard 1984). Compared with the other two types of variables that affect the implementation of low-carbon strategy of enterprises (i.e., individual heterogeneity and the business environment), the main difference of the industry environment is that it is easier to be perceived by decision makers. Existing studies have comprehensively explored the impact of the industry environment on the low-carbon strategy of enterprises. This impact is mainly reflected in the number of industry competitors (Tu and Wu 2020) and the attributes of the company's main products (Swaen et al. 2021). Whether the company's main products are terminal products and whether consumers are directly faced will greatly affect the company's initiative to implement low-carbon strategy. With increasing public awareness of environmental protection and low-carbon demand, the low-carbon degree of enterprise production and operation will greatly affect the establishment of an enterprise's external image. The empirical research of Hoffman(2001) has also confirmed that enterprises that produce and sell

final products implement a more thorough low-carbon strategy than enterprises that sell intermediate products.

In summary, the three first-level conditions of business environment, industry environment, and enterprise heterogeneity include 10 second-level conditions. These constitute the theoretical framework of low-carbon strategy choices for enterprises as applied in this paper (Fig. 1).

3 Research Design

3.1 Research method

Fuzzy set qualitative comparative analysis (fsQCA) emphasizes the use of configuration logic when analyzing complex causal relationships. This paper uses fsQCA to analyze the choice of low-carbon strategy by enterprises, which is mainly based on the following considerations: first, the choice of low-carbon strategy by enterprises is a topic with complex antecedents. Traditional regression analysis emphasized the net effect of variables, making it difficult to explain multiple concurrency; second, the prerequisite path for the implementation of a company's low-carbon strategy is not unique, and different combinations of macro and micro factors may cause it to happen. Traditional quantitative research cannot explain this path of "different routes to the same goal".

3.2 Sample selection

The following points were considered in the initial sample selection: (1) Time span: among the low-carbon policies and measures issued by China, the low-carbon city pilot policy in July 2010 was the first relatively complete policy constraint for the control of carbon emissions, which had an important impact on the follow-up carbon emission trading mechanism and green development. Therefore, the data period from 2010 to 2017 was selected. (2) Industry selection: according to the heavy pollution industries listed in the "Guidelines for Environmental Information Disclosure of Listed Companies", published by the Ministry of Ecology and Environment in 2010, 16 types of heavy pollution industries were selected as the research objects. (3) Determination of sample companies: according to the industry classification results of listed companies in the fourth quarter of 2019, published by the Securities Commission, and excluding ST and *ST companies as well as companies with missing data, 669 sample companies were obtained. In summary, this paper selects 669 listed companies in 16 heavy polluting industries at Shanghai and Shenzhen stock exchanges from 2010 to 2017, covering 175 cities across the country. The industry distribution is shown in Table 1.

Table 1
Feature statistics of sample companies

Enterprise characteristics		Number of samples	Proportion
Registration Type	State-owned enterprise	214	32%
	Non-state-owned enterprise	455	68%
Corporate Planning	large enterprise	586	87.5%
	SMEs	83	12.5%
Industry	manufacturing	606	82.44%
	Electricity, heat, gas and water production and supply	69	9.37%
	mining industry	60	8.19%
Location	Municipalities directly under the Central Government, cities under separate state planning	86	12.3%
	Other prefecture-level cities	613	87.7%

3.3 Variable selection

3.3.1 Outcome variable

Based on the improvement of quantitative methods by Yong Liu (2018) and Clarkson et al. (2008), the enterprises' low-carbon strategy are divided into low-carbon production management and low-carbon business management. The former reflects the low-carbon strategy of the production process of the enterprises, while the latter reflects the low-carbon idea implemented in the operation and management of the enterprises, which is quantified by eight dummy variables. The specific indicators are shown in Table 2.

This paper uses the companies' annual reports, social responsibility reports, environmental reports, and sustainability reports. The companies are recorded as "1" if they meet the criteria in Table 2, and recorded as "0" if they do not. The mean value of the quantitative results are taken, and the final value ranges between 0 and 1.

Table 2
Quantification table of low-carbon behavior of enterprises

Low-carbon production management	Does the company have measures or technologies to reduce the three wastes and greenhouse gas emissions?
	Whether the company invests in cleaner production processes or circular economy production methods
	Whether the company conducts R&D and production of low-carbon products
	Does the company have special expenses for technological transformation of green production?
Low-carbon business management	Whether the company's environmental management system has passed ISO 14001 certification?
	Does the company have written low-carbon management regulations, rules and other systematic measures to guide low-carbon management work?
	Whether the company has set up a special environmental management functional department?
	Does the company have awards related to low carbon?

3.3.2 Condition variable

3.3.2.1 Business environment

The business environment is defined as a "comprehensive ecosystem" of the external environment faced by enterprises in the Business Environment Assessment of Chinese Cities (Li 2019). This paper follows the practice as outlined in The Business Environment Assessment of Chinese Cities, measures the business environment of enterprises with six secondary indicators of governmental efficiency, financial services, market services, public services, innovation environment, and human resources, and includes 17 three-level indicators (as shown in Table 3).

Table 3
China's urban business environment evaluation index system

First-level index	Secondary indicators	Weights(%)
Government efficiency	General budget expenditure	50
	Government service efficiency	50
Human Resources	Average salary	40
	Number of college students	30
	Number of employees at the end of the year	30
Financial Services	Private financing efficiency	50
	Overall financing efficiency	50
Public Service	Road area per capita	15
	Water supply capacity	25
	Gas supply capacity	25
	Power supply capacity	25
	Medical and health services	10
Market environment	GDP per capita	40
	Total investment in fixed assets	30
	Amount of foreign capital actually used in the year	30
Innovation environment	Scientific expenditure	50
	Innovation Ability Index	50
Source: Li Zhijun, etc., 2019.		

3.3.2.2 Organizational environment

It is measured by the number of competitors and product attribute indicators considering the market competition degree of the enterprise. The number of competitors reflects the degree of industry concentration, which is consistent with existing research (Zhi and Hull 2012). This paper uses the natural logarithm of the competitors in the same industry. Enterprise product attributes are assessed according to corporate main products, and are assigned 0 if the enterprise is mainly selling intermediate products, or 1 if the enterprise mainly produces and sells terminal products.

3.3.2.3 Individual heterogeneity

CEO power: following an existing study (Zhou et al.2021), through the four types of power of CEOs, specific indicators are selected as shown in Table 4. To synthesize a comprehensive indicator of CEO power, the eight variables in Table 4 are averaged and the final values ranges between 0 and 1.

Table 4
CEO power quantification table

Organizational power	Does the CEO concurrently serve as the chairman of the board
	Is the CEO an internal director of the company
Expert power	Does the CEO have a senior title
	Is the CEO's tenure long enough
Ownership power	Does the CEO have equity
	Institutional investors' holdings
Reputation power	Does the CEO have a highly-educated educational background
	Does the CEO work part-time outside
<p>Manager action: the action ability of managers is measured by heterogeneity in the executive team. Following existing research, this is measured from the standard deviation coefficients of four indicators: age, gender, education level, and functional background. Among these, the codes in the indicators are consistent with the codes in the CSMAR database. Finally, the above four indicators are standardized and averaged, thus obtaining the comprehensive TMT heterogeneity. The higher the value, the higher the heterogeneity of the executive team.</p>	

3.3.3 Variable calibration

It is necessary to calibrate the variables in combination with the actual situation because FsQCA analyzes set relationships rather than variables. This paper applies the quartile point method to determine the anchor point, as well as the upper quartile point, mean value, and lower quartile point of the sample data as the calibrated complete membership point, intersection point, and complete non-affiliation point, respectively. Three anchor points are used to calibrate the result variable and condition variable. The results are shown in Table 5.

Table 5
Variable calibration anchor points

variable		location point		
		Point of complete membership	Intersection point	Point of complete non-membership
Outcome variable	Low-carbon behavior of enterprises	0.625	0.5	0.375
Condition variable	Number of competitors	4.454	3.737	3.332
	CEO power	0.714	0.428	0.285
	TMT heterogeneity	0.357	0.279	0.210
	Government efficiency	24.08	13.25	7.84
	Financial Services	32.31	8.59	2.37
	Market service	41.47	23.39	13.52
	Public Service	39.43	16.74	10.18
	Innovation environment	18.41	4.38	1.14
	Human Resources	43.76	24.08	13.3

4 Results And Discussion

4.1 Necessity analysis

The main purpose of necessity analysis is to assess the explanatory ability of each variable to the low-carbon strategy of enterprises by calculating both the "consistency" and "coverage" of the selected variables. The results (see Table 6) show that the uniformity level of the variables remains below 0.8, which indicates that the company's low-carbon behavior is the result of an interaction between internal and external environments.

Table 6
Necessity analysis

result	Enterprise's high-level low-carbon behavior		Enterprise's low-level low-carbon behavior	
Condition variable	consistency	Coverage	consistency	Coverage
Number of competitors	0.537 2	0.896 2	0.462 8	0.853 5
~Number of competitors	0.439 2	0.103 8	0.560 8	0.146 5
product properties	0.540 9	0.329 5	0.459 1	0.309 2
~Product attributes	0.517 6	0.670 5	0.482 4	0.690 8
TMT heterogeneity	0.554 4	0.524 7	0.513 6	0.537 3
~TMT heterogeneity	0.563 2	0.539 7	0.504 0	0.533 8
CEO power	0.560 0	0.576 1	0.520 9	0.592 4
~CEO power	0.579 0	0.507 1	0.516 0	0.499 5
Government efficiency	0.564 7	0.509 9	0.513 9	0.512 9
~Government efficiency	0.560 1	0.561 1	0.510 7	0.565 5
Financial Services	0.567 0	0.528 3	0.518 8	0.534 3
~Financial Services	0.567 0	0.551 6	0.515 1	0.554 0
Market environment	0.546 6	0.520 3	0.521 1	0.548 3
~Market environment	0.571 1	0.544 1	0.496 5	0.523 0
Public Service	0.569 3	0.502 1	0.512 7	0.499 8
~Public Service	0.557 6	0.570 2	0.513 1	0.580 1
Innovation environment	0.563 8	0.530 0	0.520 8	0.541 1
~Innovation Environment	0.569 7	0.549 5	0.512 8	0.546 8
Human Resources	0.545 6	0.508 3	0.527 1	0.543 0
~Human Resources	0.575 0	0.559 4	0.494 7	0.532 0

4.2 Adequacy analysis

In this paper, the consistency threshold and frequency threshold are not directly set, but determined on the basis of the following four principles, which is in line with the practice of Schneider and Wagemann

(2012). First, truth tables with results of 0 and 1 should be covered and roughly balanced. Second, the frequency threshold covers at least 75% of the observed samples (Ragin 2006). Third, the minimum value of PRI consistency shall be greater than or equal to 0.75 in order to reduce the number of conflicting configurations. Fourth, possible simultaneous subset relations should be avoided.

Considering the trade-off relationship between the coincidence rate and the coverage rate and the abnormal value assignment of a number of case variables in the large sample analysis, the consistency threshold was set to 0.75 and the frequency threshold was set to 5. Complex solutions, intermediate solutions, and concise solutions were obtained. The configuration results, obtained through Boolean algebra operation on the intermediate solution and the reduced solution, are shown in Table 7.

Table 7
Configuration analysis of realizing enterprise low-carbon strategy

Condition variable		configuration							
		Low-level business environment			Mid-level business environment		High-level business environment		
		1	2	3	4	5	6	7	8
Industry environment	Number of competitors	■	●	●	■	■	■	■	■
	Product Nature	■	■	□	●	●	●	●	●
Individual heterogeneity	CEO power	■	□	■	●	●	●	●	●
	TMT heterogeneity	□	■	□	●	●	□	●	□
Business environment	Government efficiency	□			□	■	■	■	■
	Financial Services	□	□	□	■	□	■	■	■
	Market service			■	■	■	■	■	■
	Public Service				□	■	■	■	■
	Innovation environment			□	□	■	■	■	■
	Human Resources	□	□	■	■	□	■	■	■
consistency		0.9185	0.9150	0.9325	0.8477	0.9381	0.8780	0.8915	0.8520
Original coverage		0.1677	0.1149	0.1548	0.0189	0.0367	0.1676	0.1361	0.0462
Unique coverage		0.0237	0.0033	0.0082	0.0034	0.0048	0.0086	0.0181	0.0033
Overall consistency		0.862919							
Overall coverage		0.685767							
Note: Follow Ragin and Fiss (2011) to present the QCA results, the solid circle representation conditions, ● Represents core conditions, ■ Indicates the edge condition, ● indicates the lack of core conditions, □ indicates the lack of the edge condition, - means one The fuzzy state, that is, the condition can be deleted.									

Through the FsQCA configuration analysis of the internal and external environment of 699 heavily polluting enterprises in 175 cities in China, we find that the consistency of the overall solution is 0.862919, which is much higher than the acceptable degree of consistency of 0.75. The overall coverage is 0.685767, indicating that this configuration can explain why more than 68% of heavy-polluting enterprises choose low-carbon strategies. It should be noted that a large coverage rate implies that the existing instances that achieve a given result have a large proportion of a given condition combination; however, a small coverage rate does not mean that the given result cannot be achieved. Therefore, the eight configurations can be regarded as a combination of conditions that are sufficient to create a low-carbon strategy of an enterprise.

According to the different business environments corresponding to the eight condition configurations, these can be summarized into three categories (see Fig. 1). The core condition for the selection of a low-carbon strategy is the number of competitors in a low-level business environment (corresponding to configurations 1, 2, and 3); and the core condition for selecting a low-carbon strategy is CEO power * TMT heterogeneity * product attributes in a medium-to-high level business environment (corresponding to configurations 4, 5, 6, 7, 8, and 9).

4.2.1 Low-carbon strategy of enterprises under a low-level business environment

The results in the first and second columns of Table 7 show that none of the six business environment condition variables exist in configurations 1 and 2, indicating that the external environment of the company's production and operation is relatively poor. The limitation of the external resources companies can obtain, coupled with the concentration of competitors in the industry, further reduce the company's living space. The main products are sold to consumers. If the product is poor in quality, the company will face consumer complaints and other problems. In this "siege on all sides", a highly powerful CEO or a highly heterogeneous executive team is a key condition for companies to implement a low-carbon strategy. Therefore, this paper identifies configurations 1 and 2 as "Survival Low-Carbon Strategy".

The results in the third column of Table 7 show that the companies in configuration 3 do not directly face consumers, and thus, these companies have insufficient low-carbon motivation from the consumer side (Swaen 2021). The most direct reason for the implementation of the strategy is the high density of competitors in the industry. Low-carbon level and high-power CEOs would consciously adapt to the industry environment and adopt the same low-carbon strategy. Under this configuration, the company's strategy choices are more likely caused by evaluations of competitors and predictions of the future development of the entire industry to maintain or expand the current corporate market share. Therefore, this paper identifies configuration 3 as "a firm-footed low-carbon strategy."

4.2.2 Low-carbon strategy of enterprises under a medium-level business environment

The results in the fourth column of Table 7 show that enterprises are facing a dual-driven business environment in configuration 4, driven by resources and financial services under the guidance of the

market. In this business environment, despite the insufficiency of the market innovation intensity, enterprises can still obtain a high level of human resources and a better financial environment. These provide a good economic foundation for the purchase of environmental protection equipment and for the transformation of production technology. With regard to the enterprise itself, the products are consumer oriented and the industry competitors are intensive, which provides sufficient motivation for the enterprise to choose a low-carbon strategy. Therefore, this configuration reflects the low-carbon strategy generated when the enterprise has pressure, the CEO has power and financial resources are available. Therefore, this paper identifies configuration 4 as "larger and stronger low-carbon strategy".

The results in the fifth column of Table 7 show that enterprises are facing an innovation driven business environment under the dual leadership of the market and the government in configuration 5. Under this business environment, all external conditions required for business operations are basically optimal, and the participation of the government has imposed strong environmental pressure on enterprises. It has also been confirmed that an efficient governmental environment would exert a significant incentive effect on environmental protection such as low-carbon production (Khanna 2010). Therefore, the decision-makers of enterprises are bound to adopt a low-carbon strategy when the pressure of government environmental regulation and market competition occur at the same time. In addition, a high-level innovation environment also provides a good technical foundation for low-carbon strategy. Under this configuration, the enterprises' low-carbon strategy is derived from "policy demand + industry demand + market foundation". Therefore, configuration 5 is identified as "adapted to the trend of low-carbon strategy".

4.2.3 Low-carbon strategy of enterprises under a high-level business environment

The results in the sixth, seventh, and eighth columns of Table 7 show that the enterprises under configurations 6, 7, and 8 are all in highly sophisticated business environments. This indicates that these enterprises have the ability to obtain all external resources needed for their own development. Compared with the pressure from competitors, enterprises in a high-level business environment are more concerned about consumers' wishes and provide them with higher-quality products, not merely to gain a greater market share within the industry. Under this configuration, managers' strategic decision-making is no longer limited by the inherent thinking of peer competition and survival. Instead, managers are more likely to focus on establishing a specific corporate image, establishing a low-carbon brand, and creating a market space where no one can compete. This also leads to the implementation of the "blue ocean", which is a concrete manifestation of "strategy". Therefore, configurations 6, 7, and 8 are identified as "value innovation-based low-carbon strategy".

4.3 Robustness test

In this paper, the robustness test is carried out by adjusting the consistency threshold and frequency threshold which is in line with existing practice (Ragin and Fiss 2008). The results are not presented in this paper due to length limitation. First, the PRI consistency increased from 0.75 to 0.80, i.e., the analysis was repeated using a more stringent threshold. The results show that the generated configuration basically remains identical. Second, when the threshold of the number of cases increased to 6, the results show that

the generated configuration basically remains identical. Finally, it can be assumed that the results obtained are robust.

5 Concluding Remarks

The low-carbon strategy of industrial enterprises have received increasing attention in the context of carbon neutrality. This paper uses fsQCA analysis to assess the linkage effect of industry environment, business environment, and individual heterogeneity on enterprises' low-carbon strategy. A multi-theoretical perspective is applied and the motivations for enterprises' low-carbon strategy are exploratively identified. The antecedent conditions and motivation differences of these configurations are compared. The conclusion of this paper does not deny the interpretation results of existing theories on enterprises' low-carbon strategy, but reveals the core conditions and complex influence mechanism affecting enterprises' low-carbon strategy under different business environments from the perspective of configuration.

The introduction of the fsQCA method provides an overall perspective for the complex interaction and causal asymmetry between the conditions behind the choice of low-carbon strategy, and further deepens the answer to this problem in the existing literature. The concluding remarks are summarized in the following:

First, single factor does not constitute a necessary condition for enterprises to implement low-carbon strategy judging from the results of necessity analysis. This further confirms the complex causality of enterprises' low-carbon strategy and the necessity of this research. The configurations under the three different business levels fully illustrate the "different paths to the same goal" of enterprises' low-carbon strategy.

Second, from the perspective of the low-carbon strategy configuration of enterprises, the importance of the three indicators follow the order of industry environment, individual heterogeneity, and business environment. The existing literature emphasized that external environment promotes the implementation of low-carbon strategy of enterprises; however, the research conclusions of this paper show that no matter whether the level of business environment is high or low, as long as other conditions are met, the choice of low-carbon strategy could also occur. The environmental pressure imposed by the industry and the strong decision-making ability within a company form a complementary relationship, which promotes the implementation of the enterprises' low-carbon strategy. It is worth noting that no relationship exists absolutely in the real situation. In the case of a highly sophisticated business environment, even if management power is dispersed, it is possible to produce a low-carbon strategy (see configuration 6). In addition, with the improvement of business environment, the number of competitors changes from a core condition to a marginal condition, while product attributes change from marginal conditions to core conditions. This indicates that a high-level business environment can help improve managers' decision-making foresight. The decision-maker's vision has moved beyond competitors to "buyer demand" and has crossed the existing competitive boundary. The enterprises' low-carbon performance may exceed local environmental protection standards and may even become a model in the industry. This is an important measure for enterprises to conduct value innovation and implement the "blue ocean strategy".

Third, the CEO or senior management team will not adopt a low-carbon strategy alone. The low-carbon choice of enterprises needs sufficient change motivation from the outside, which shows the interest driving of the enterprise itself. When environmental governance hinders further development of the enterprises, they would take low-carbon development as an enterprise strategy. With the improvement of business environment, enterprises become increasingly proactive in implementing low-carbon strategies. In addition, the three types of configurations include the number of competitors, which reflects the industry characteristics and severe challenges faced by China's heavy pollution enterprises in recent years, and also shows the necessity of low-carbon strategy choice.

This study still has a number of limitations. First, since it is difficult to quantify the enterprise's low-carbon strategy with specific indicators, this paper mainly judges the implementation of enterprise's low-carbon strategy according to the existing disclosure in enterprise's reports. However, it is found that most enterprises only disclose qualitatively and lack accurate index data. Therefore, it may cause deviation in the judgment of enterprises' low-carbon strategy. Second, this paper adopts fsQCA to provide new empirical evidence for the research of low-carbon strategy choice of enterprises. However, this is not a complete causal explanation for the enterprise's low-carbon strategy. There may be other variables that would have an impact on enterprise's low-carbon strategy. Finally, in the multi-perspective theoretical framework constructed in this paper, only two secondary indicators of business environment and industry environment are considered for the measurement of macro environment. The secondary indicators under enterprise heterogeneity only consider CEO power and management action. In fact, the explanation of enterprises' low-carbon strategy under traditional economics and enterprise heterogeneity theory is far more than that. Thus, the exploration of the linkage effect of various factors will be an important research direction in the future.

Declarations

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Ethical Approval

Not applicable.

Consent to Participate

Not applicable

Consent to Publish

Not applicable

Authors Contributions

Ziyi Li analyzed and interpreted the data. Wenxi Wang was a major contributor in writing the manuscript. All authors read and approved the final manuscript.

Funding

We acknowledge the financial support from Youth project of National Social Science Foundation of China (No. 17CGJ024), Planning project of philosophy and Social Sciences in Shanxi Province (No. 2020YJ166), Research project of philosophy and Social Sciences in Colleges and universities of Shanxi Province (No. 2020W133).

Competing Interests

The authors declare no competing interests.

Availability of data and materials

All data generated or analysed during this study are included in this published article.

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Figures

Figure 1

Theoretical framework