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Configuration Paths for High-Quality Development of Listed Companies Based on the TOE Framework: Evidence from China's High-Tech Enterprises

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Abstract: In the context of dual-carbon goals, high-quality development has become an inevitable trend for technology enterprises. This study employs a dynamic Qualitative Comparative Analysis (QCA) method, based on the technology, organization, and environment (TOE) framework theory, and a configurational analysis perspective. Using panel data from Chinese listed high- and new-technology enterprises from 2013 to 2022 as the research sample, this study explores the combinatorial paths that drive high-quality development. The research findings are as follows: (1) The antecedent factors for high-quality development exhibit "multiple concurrent" characteristics, and a single condition does not constitute a necessary condition. (2) Based on the three driving paths for high-quality development, three models can be summarized under the synergistic effects of different antecedent conditions: "multi-factor influence type", "green-innovation-led type", and "digital-technology-driven type". Regardless of the path, R&D investment and enterprise scale are indispensable driving factors. (3) Under specific objective endowment conditions, continuous digital transformation by enterprises can alleviate the challenges caused by market competition deficiencies. When enterprise executives possess a high level of green cognition, they can compensate for inadequate environmental regulations. Therefore, enterprises need to enhance scale and R&D investment, based on existing endowments, and shift from a single-factor influence concept to a comprehensive selection approach.

Keywords: high-quality development; configurational analysis; dynamic QCA; TOE framework

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1. Introduction

The report of the 20th National Congress of the Communist Party of China explicitly states that "high-quality development is the first and foremost task in building a modern socialist country in all respects". In the context of innovation-driven development strategies, high- and new-technology enterprises at the forefront of science and technology are crucial to sustaining high-quality economic development [1]. The high-quality development of high- and new-technology enterprises, as key to realizing China's high-quality economic development, implies that they must optimize all production factors, under the given conditions, to maximize benefits. With the rise of the digital economy, enterprises face an increasingly complex and dynamic environment, marked by shorter cycles of change in both environmental and organizational elements [2]. Enterprise development is being significantly hindered by problems, such as "capital shortages, low innovation performance, and insufficient development momentum" [3]. In the context of China's economic transformation and efforts to enhance development quality, promoting high-quality enterprise development has emerged as a significant research topic with substantial practical relevance. The high-quality development of high-tech enterprises is the cumulative result of the long-term synergistic effects of technological progress, organizational operations, and the external environment. Previous literature has overlooked the joint interactions among these three aspects, the continuous nature of high-quality development, and the potential dynamic pathways for combination.

In view of this, an in-depth exploration of the driving factors and combination paths for the high-quality development of high- and new-technology enterprises is vital for the country's high-quality development. This study aims to clarify several key questions: What are the driving factors for the high-quality development of high- and new-technology enterprises? Which factor combinations achieve high-quality development? Do different combinations of factors evolve over time and, if so, through what mechanisms? These issues urgently require active exploration by both industry and academia. This study develops a technology, organization, and environment (TOE) analysis framework specifically designed for the developmental realities of publicly listed high-tech enterprises. By integrating contemporary trends and economic development requirements, the TOE framework is refined into three dimensions: technology, organization, and environment. Specific influencing factors within each dimension are identified based on relevant theories and research findings. We select Chinese A-share listed high- and new-technology enterprises from 2013 to 2022 as our research sample. Using dynamic Qualitative Comparative Analysis (QCA), we explore the equivalent driving mechanisms and potential substitution relationships that promote high-quality enterprise development, and we study the driving mechanisms leading to non-high-quality development based on the asymmetry theory.

The potential contributions of this paper are as follows: First, it extends the application of the technology, organization, and environment (TOE) framework by adopting a configurational research perspective on the high-quality development of listed high-tech enterprises. Second, while existing studies primarily adopt a static approach, relying on macro-level data and focusing on individual policies, this paper enhances the methodology by exploring high-quality development through a configurational perspective at the micro level of corporate governance. To address the limitations of traditional Qualitative Comparative Analysis (QCA), which is confined to cross-sectional data and cannot analyze temporal and individual effects, this paper employs dynamic QCA to analyze panel data, thereby overcoming these constraints. This approach enables the TOE framework to capture the complex causal relationships that evolve over time. This study investigates the conditions and mechanisms for enhancing the high-quality development of listed high-tech enterprises, providing both theoretical support and empirical data to address the bottlenecks in high-quality development and to inform the formulation of relevant policies. Furthermore, as the world's largest emerging economy, China has not fully prioritized the enhancement of quality in high-tech enterprises during its rapid economic growth, facing significant environmental challenges, a phenomenon common among many developing countries, and the adaptability and innovation demonstrated by its high-tech enterprises during this process offer valuable lessons for similar enterprises in other nations. Thus, this research not only offers guidance for the future development trajectory of listed high-tech enterprises in China but also serves as a valuable reference for the construction and development of high-tech enterprises in other developing countries worldwide.

2. Literature Review and Analytical Framework

2.1. High-Quality Development

In the context of the new era, high-quality development has become a consensus. High-quality development, the direction of China's economic development, represents a high-level and optimal state of economic development quality. Economic high-quality development represents a foundational model shaped by the synergistic effects of China's "Five Development Concepts". It is both a product of high-quality social and governance development and a manifestation of comprehensive, balanced growth [4]. As an overarching concept, high-quality development constitutes a long-term, dynamic system that integrates macroeconomics, regions, industries, and micro-level enterprises. Its institutional essence lies in fostering transformative improvements in the quality, driving forces, and efficiency of economic development to address the evolving aspirations of people for a better life. Regarding high-quality development, academic research primarily focuses on macro and meso levels, specifically including theoretical analyses, such as economic implications, constructing evaluation indicator systems, strategic approaches, and target requirements, as well as examining the impact of factors, like smog pollution, financial structure, industrial agglomeration, environmental regulation [5], ESG information disclosure [6], infrastructure investment, internal enterprise innovation and the external technological environment [7], fiscal decentralization [8], and regional financial innovation [9], on high-quality economic development. There is a lack of research on how to promote high-quality development at the microeconomic level, and the continuous cumulative nature of high-quality development is neglected. Ultimately, high-quality economic development must be realized through high-quality enterprise development; therefore, exploring ways to enhance the latter is mandatory to achieve the former. In the academic community, a consensus on the definition of high-quality development in enterprises has yet to be established. From the perspective of internal characteristics, some scholars argue that the high-quality development of enterprises represents an ideal state characterized by superior product and service quality, as well as a well-established internal management mechanism [10]. Some scholars contend that high-quality development is reflected in the continuous improvement of total factor productivity. The concept remains open to diverse interpretations and ongoing academic debate. The pursuit of high-quality development by enterprises is still in the exploratory stage. Understanding the connotations of high-quality development from the perspective of the enterprises themselves and determining how to implement it are urgent issues that need to be addressed.

Research on the factors influencing high-quality enterprise development can be categorized as shown in Table 1.

Table 1. Research on factors influencing enterprise high-quality development by different scholars.

Perspective	Representative Scholars	Influencing Factors	Methods	Effects	Purpose
Internal Factors External Factors	Zhang et al. [11]	Technological innovation	Improve organizational resilience and operational efficiency, promote production process and product upgrade	Reduce costs and transaction fees, inject vitality into enterprises bringing competitive advantages, meet consumer differentiation	Promote high-quality development
	Sun and Fang [12]	Digital transformation	Enhance resource collection and utilization, comprehensively empower production operations, organizational management, and technological innovation	Improve corporate social responsibility performance, perfect corporate governance	
Complex Factors Perspective Internal Factors	Healy and Palepu [13]	Information disclosure	High-quality information disclosure, obtain better financing conditions	Reduce information asymmetry, increase market value	
	Chen and Liu [14]	Government subsidies	Provide subsidies, release positive signals, etc.	Alleviate enterprise financing constraints, improve performance	

	Zhang and Ma [15]	Business environment	Incentivize enterprise innovation, reduce non-productive expenditures, etc.	Provide differentiated services and products
External Factors	Wang et al. [16]	Capabilities, technology, government, etc.	Enhance capability and technological progress, improve factor allocation efficiency, government support, etc.	Joint efforts from multiple parties

Source: compiled from relevant literature.

A review of the literature reveals that the factors influencing high-quality development are interrelated and mutually influential, forming a complex, multi-factor causal relationship. This relationship often lacks consistency, as certain combinations of factors may foster high-quality development, while others may negatively affect outcomes. Consequently, the causal relationship in high-quality development is asymmetrical, requiring different combinations of factors to explain its realization. Empirical research, constrained by the availability of large sample data and the quantifiability of evaluation dimensions, is relatively insufficient compared to theoretical studies. While a significant body of literature has focused on the driving factors of high-quality development in enterprises, most studies have not empirically tested these factors, nor have they explored them from a configurational perspective of sufficiency and necessity. Further research is required in the following areas: First, the existing literature rarely analyzes how high- and new-technology enterprises promote high-quality development at the micro level. Second, high-quality development is a dynamic process, jointly influenced by multiple factors. Existing research, however, mostly focuses on analyzing the marginal "net effect" of single factors [17], neglecting the synergistic effects among elements and failing to form effective driving paths for high-quality development. Lastly, current research mainly analyzes issues from a static perspective, focusing on single policies and using traditional QCA methods to study configurational paths. Limited by cross-sectional data, these studies cannot analyze time and individual effects, thereby failing to effectively explain the impact of element combinations on enterprise high-quality development over time, or interpret the evolutionary patterns and complex causal relationships of configurations.

2.2. TOE Analysis Framework

In 1990, Tornatzky and Fleischer introduced the technology, organization, and environment (TOE) theoretical framework but did not specify particular variables for its three dimensions. This omission has rendered the framework highly adaptable and flexible for both theoretical and practical applications. Scholars have continuously expanded the TOE framework, customizing it to address specific research subjects and real-world contexts. It has been widely applied in areas such as enterprise economics and the development of the big data industry [18]. In management studies, both macroeconomic systems and micro-level enterprises are regarded as complex economic systems composed of numerous interacting agents operating under conditions of limited information. The TOE framework serves as a tool to uncover how multiple factors interact to influence economic activities [19]. Specifically, extending the TOE framework to a configurational research perspective on the high-quality development of listed high-tech enterprises is grounded in several foundational insights: first, the economy operates as a complex system driven by technology [20]; second, managing such systems necessitates the integration of government and market functions [21]; and third, individual and organizational behaviors within complex systems are intrinsically linked to environmental openness and dynamics [21]. In summary, the main components and analytical paradigm of the TOE framework align closely with the principles of managing complex economic systems. By refining the framework to reflect specific contexts and research questions, it becomes a powerful tool for addressing challenges in increasingly dynamic and complex management scenarios, providing robust theoretical support for studying the high-quality development of listed high-tech enterprises. However, past research has often emphasized the individual effects of technology, organization, and environment within the TOE framework, neglecting the interplay and alignment among these dimensions. A focus on the relationships between multiple conditions offers greater explanatory power for the complexity of research findings. In light of this, introducing a configurational perspective and employing dynamic Qualitative Comparative Analysis (QCA) to refine and analyze the technological, organizational, and environmental dimensions that drive the high-quality development of high-tech enterprises is of significant theoretical and practical importance.

2.3. TOE Analysis Framework for Driving Factors of High-Quality Development in Listed High- and New-Technology Enterprises

High-quality enterprise development involves complex causal relationships [22] and is typically the result of multiple factors acting together, albeit with varying relative importance [17]. This poses a challenge for enterprise managers to effectively identify the multiple conditions, including their synergistic effects, that affect high-quality development. Therefore, managers must choose appropriate reform strategies according to their development cycles and nature, combined with the elemental endowments. The essence of high-quality development in high- and new-technology enterprises lies in the long-term accumulation and synergistic effects of three conditions: technological innovation, organizational operations, and the external environment. Some scholars have categorized the internal and external factors of enterprises into technological, organizational, and environmental, forming the TOE theoretical analysis framework, which allows for variable selection and analysis based on specific research questions. This study focuses on the actual development of listed companies and considers the reality that pro-environmental behavior is influenced by multiple factors, by conducting a configurational analysis based on technological, organizational, and environmental factors. It constructs a TOE analysis framework that influences high-quality development, in combination with the new requirements and situations facing economic development.

2.3.1. Technological Dimension

According to the resource-based theory, the resources and capabilities of high- and new-technology enterprises determine their competitive advantages. Digital transformation endows enterprises with new development momentum [23], facilitating the integration of existing and novel resources and capabilities. Xu et al. [24] discover that digital transformation can significantly improve the environmental performance of an enterprise. Therefore, enterprises need to focus on applying and upgrading digital technologies, such as blockchain [25] and big data [26]. Wu et al. [27] believe that digital transformation can strengthen positive market expectations for enterprises, thus enhancing their value and innovation performance. Li and Li [28] argue that listed manufacturing enterprises, undertaking digital transformation and green technological innovation, can significantly improve their green performance. However, according to Schumpeter, innovation is a crucial driving force for the high-quality development of high- and new-technology enterprises. R&D investment is a preparatory stage for accelerating digital transformation and an important means of enhancing innovation capabilities and technological levels. It can help reduce energy consumption, improve production efficiency, and consequently reduce social and environmental risks. Kong and Shi [29] believe that developing and applying cleaner technologies can help enterprises generate more economic benefits and achieve dual carbon goals, significantly promoting high-quality development.

2.3.2. Organizational Dimension

The measures taken by high- and new-technology enterprises to respond to external environmental changes are constrained by the availability of resources, such as enterprise capital, scale, and reputation. A prerequisite for high-quality development is enterprise scale, with both the quality and quantity of resources possessed being related to it. Listed companies with better operating conditions and larger scales are more proactive in fulfilling social responsibilities, demonstrating more autonomy in decision-making [30]. Based on the upper echelons theory, the key to the development direction and strategic decision-making of enterprises is the green cognition of their executives. The possession of high-quality green development concepts by an executive team is conducive to the transformation of the enterprise's development model towards sustainability. Li et al. [31] believe that a higher level of green cognition in the executive team will improve the environmental and economic performance of an enterprise, significantly positively regulating its ability to acquire and integrate green resources, thereby promoting its emphasis on environmental protection [32]. Orazalin and Baydauletoy [33] found that board gender diversity facilitates high-quality enterprise development. Xue et al. [34] confirm that corporate social responsibility significantly promotes the high-quality development of listed companies through environmental investment, green innovation, and corporate governance. Wu and Jin [35] confirm the positive impact of corporate social responsibility on high-quality development from a corporate governance perspective, emphasizing the mediating role of measures like management capabilities and internal controls. Wang et al. [36] state that high-quality internal controls can effectively promote the high-quality development of enterprises.

2.3.3. Environmental Dimension

Based on the information transmission theory, enterprises convey positive information to maintain or expand market share under fierce industry competition, compelling them to adopt pro-environmental behaviors more proactively. For enterprises, pro-environmental behavior is closely related to achieving high-quality development. In existing research, the factors influencing the pro-environmental behavior of enterprises are primarily categorized into external factors, internal factors, and stakeholder pressure. Among these, internal factors are the fundamental reasons for pro-environmental behavior; these incorporate employee environmental awareness, enterprise scale [37], enterprise performance, equity nature, leadership type [38], profitability, environmental concern and cognition, the nature of property rights, and the dual role of the enterprise chairman and general manager. External factors are the direct causes of enterprises' pro-environmental behavior; these include local community pressure, market competition, environmental organization supervision, policy pressure and public pressure, regional economic development, geographical factors, low-carbon city pilot construction, fiscal incentives, etc. Stakeholder pressure, from the government, managers, employees, investors, and consumers, is an important factor driving enterprises to implement pro-environmental behavior. Wu et al. [39] find that the government expenditure structure and high-quality development demonstrate an "inverted U-shape" relationship, with a rise in government corruption levels directly reducing enterprise high-quality development. Dong and Wang [40] discover that government environmental regulations could promote green technological innovation in enterprises. Blinova et al. [41] believe that effective ESG factor management is conducive to enterprise sustainability. Xue et al. [42] argue that green institutional pressure from local governments promotes enterprise innovation. Liu and Li [43] find that criminal law regulations that optimize the business environment play a significant role in promoting enterprise innovation and development. However, government financial subsidies are an indispensable strategic resource for enterprises [44]. Liu et al. [45] believe that, based on increased industrial complexity, government subsidy regulation can incentivize enterprise green innovation, thereby promoting high-quality development.

In summary, the high-quality development of listed high-tech enterprises involves complex causal relationships. The technology, organization, and environment (TOE) analytical framework aligns with the management principles of complex economic systems, effectively elucidating the mechanisms by which multiple factors interact and influence economic activities. This framework provides robust theoretical support for studying the high-quality development of listed high-tech enterprises. This paper extends the TOE framework to a group research perspective, adapting it to the characteristics of complex economic systems. Furthermore, it refines the framework based on the specific context of the enterprise and the research problem. By employing resource-based theory, Schumpeter's innovation theory, higher-order theory, and information transfer theory, the paper identifies key factors that affect the high-quality development of high-tech enterprises. This study ultimately selects seven antecedent conditions to conduct a configurational analysis on three enterprise dimensions to improve high-quality development, exploring the most effective configurations of various influencing factors. The theoretical analysis framework is illustrated in Figure 1.

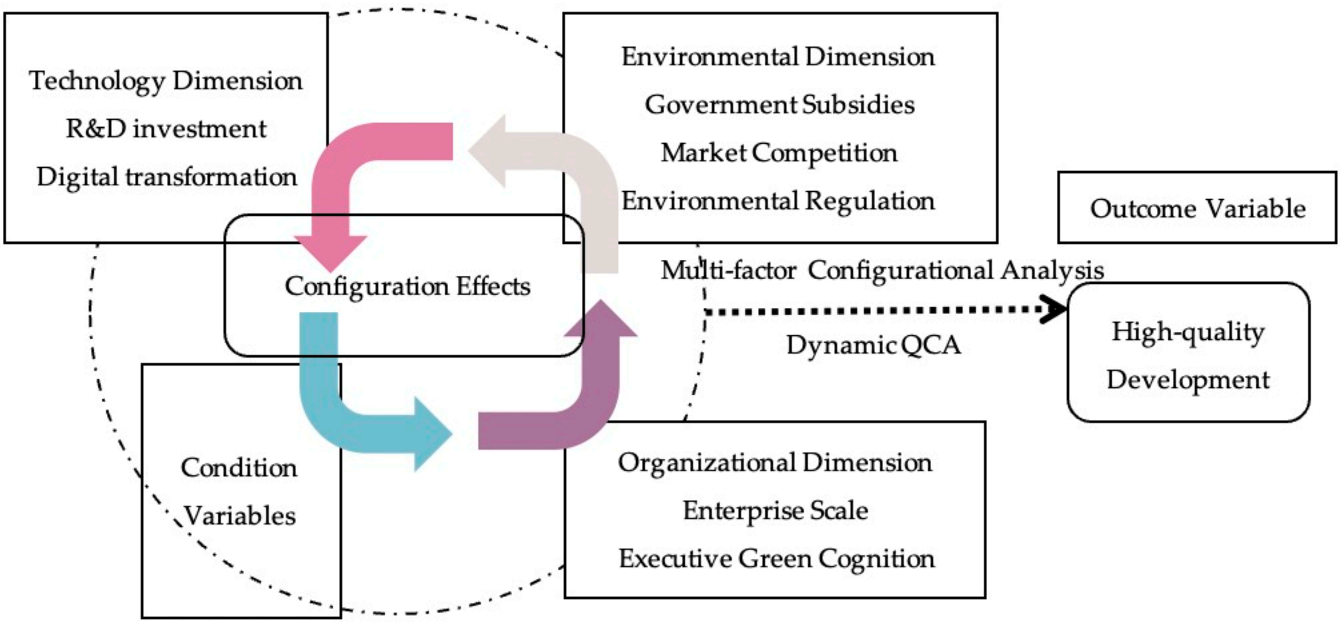

Figure 1. Configurational analysis framework for high-quality development of listed high- and new-technology enterprises.

3. Research Design

3.1. Research Method

In recent years, the configurational analysis method has gained significant attention from scholars for its ability to address causal complexity [46]. Unlike traditional methods where influencing factors are often studied in isolation, configurational analysis examines the interactions and alignments of factors, revealing multiple pathways to achieving an outcome. To address the limitations of traditional correlation-based theories and methods, a new management research paradigm has emerged, rooted in the configurational perspective and the Qualitative Comparative Analysis (QCA) method [47]. This approach identifies equivalent strategic combinations and has been widely applied across fields such as corporate governance [48], entrepreneurship research [49], digital transformation, and information systems [50]. The QCA method differs fundamentally from traditional symmetric quantitative approaches, as it avoids many endogenous issues inherent in conventional methods [2]. By leveraging multi-case comparisons, set theory, Boolean algebra analysis, and systematic logical processing, QCA establishes clear necessary and sufficient relationships. It describes the asymmetry of causal relationships through set theory [51], making it particularly effective in addressing endogeneity. Moreover, by analyzing different combinations of conditions and incorporating time-series data, QCA structurally captures changes in causal paths and their long-term effects [52,53]. Unlike statistical methods, such as fixed-effects models, which rely heavily on linear relationships and specific data assumptions, QCA accommodates more complex causal mechanisms, particularly those grounded in qualitative data. Dynamic QCA offers a distinct advantage in capturing nonlinear relationships and interactions within complex causal chains. Grounded in Boolean algebra, it examines set relationships among factor combinations rather than their correlations, thus avoiding omitted variable bias [54]. This eliminates endogeneity issues present in traditional correlation analyses and, being independent of random sampling, mitigates the sampling bias inherent in traditional random sampling assumptions.

Currently, the QCA method for analyzing complex causal issues is mainly based on a static perspective [50]. Traditional QCA methods typically rely on cross-sectional data for configurational studies, which face the issue of a "time blind spot" and are unable to effectively elucidate the interactive relationships between complex causality and the time dimension. However, in increasingly complex and dynamic management scenarios, traditional configurational theory and QCA methods lack in-depth discussion of the issues related to the time and dynamic evolution of configurations, as well as a fine-grained analysis of the complex relationships and connecting mechanisms within configurations [2]. Dynamic QCA, which is distinct from previous linear regression methods and static QCA, effectively addresses the limitation of traditional QCA methods, which can only analyze cross-sectional data. It requires measurement and analysis from three dimensions: between, within, and pooled, and adjusts for consistency to capture the subtle changes in configurations across time and space. This approach can reveal the complex dynamic impacts of multiple trajectories formed by multiple conditions on outcomes at different times [55]. The key to solving high-quality development configurations lies in studying the combination of different antecedent conditions and whether one or many of these arrangements can achieve high-quality development. Given this, research on the multi-dimensional influencing factors and differentiated driving paths of high-quality development in enterprises requires the adoption of configurational thinking and dynamic QCA methods. This paper integrates the TOE framework to propose a comprehensive analytical framework for analyzing high-quality enterprise development., incorporating the time element into QCA [2]. The decision to use dynamic QCA is based on the following considerations: (1) The high-quality development of listed high-tech enterprises involves the interaction and matching of multi-dimensional elements. The dynamic QCA method can reveal the interrelationships between these elements, thereby providing a deeper understanding of how different combinations of factors drive high-quality development in enterprises. (2) This paper aims to explore whether there are differentiated driving paths for the high-quality development of high-tech enterprises. The application of dynamic QCA can further identify distinct driving paths for high-quality development, offering important references for enterprises to plan appropriate and effective development paths based on their own endowments. (3) This paper seeks to investigate whether there are potential substitutive relationships between different dimensional factors in driving high-quality development in enterprises. Dynamic QCA has a significant advantage in exploring potential substitution effects between different causal conditions [47]. (4) The factors that lead to high-quality or non-high-quality development in enterprises may exhibit asymmetry. Dynamic QCA allows for the comparative analysis of this asymmetry, thus expanding the theoretical contributions of the research. Using the R language software, an empirical analysis was conducted on panel data of 1048 high- and new-technology enterprises listed on the A-share market from 2013 to 2022 across three dimensions: aggregate, between-group, and within-group. This approach identifies the individual and time effects of configurations [56] and explores the sufficient and necessary conditions and complex causal mechanisms of multiple concurrent factors influencing the high-quality development of high- and new-technology enterprises.

3.2. Data Sources

This study selects panel data from listed high- and new-technology enterprises from 2013 to 2022 as the initial research sample. The main reason is that the criterion for high- and new-technology enterprises is based on enterprise qualification certification data from the CSMAR database; we selected enterprises continuously recognized as high-tech by governments at various levels during the sample period. Other relevant data were derived mainly from CSMAR, Mark Data Network, annual reports of listed companies, disclosed on the official websites of the Shenzhen and Shanghai Stock Exchanges, and relevant government work reports. To enhance the match between the data and the research subject [57], the following samples were excluded: (1) ST, * ST, and delisted samples; (2) samples with less than 10 years of listing; and (3) special financial enterprises. Finally, 10-year data from 1048 listed high- and new-technology enterprises were selected. Missing data were supplemented using the annual reports of listed companies and multiple imputation methods from the MICE software package in R version 4.2.1 . Additionally, to avoid the influence of outliers, we applied 1% winsorization to all continuous variables in both tails.

3.3. Variable Selection and Measurement

Regarding the measurement of the outcome variables, the explained variable was high-quality development. High-quality development in enterprises is inherently dynamic, characterized by the continuous enhancement of corporate capabilities and the pursuit of improved development quality. Regarding metrics for measuring high-quality development, some scholars advocate for a comprehensive evaluation system [58]. While this approach facilitates a multi-dimensional assessment of high-tech enterprises' development status, a unified evaluation indicator system is yet to be established. Consequently, some scholars argue that this method lacks standardization and remains highly subjective, undermining the scientific validity of its conclusions. Additionally, many indicators face significant measurement challenges and are rarely applied in studies [59]. Based on the absence of a formal definition of high-quality enterprise development in academia, it is evident that changes in an enterprise's technology, products, or position within the industrial value chain are reflected in its productivity. In response, the use of intermediary variables, such as total factor productivity (TFP), is considered more robust. As an integrated measure of all factors' productivity within an enterprise, TFP provides a more comprehensive reflection of the high-quality development level of China's high-tech enterprises [60]. Based on the total factor productivity (TFP) indicator, which includes information on enterprise technological progress, product quality, and resource allocation capabilities, total factor productivity was used to measure the level of high-quality enterprise development. We considered its sample selection and endogeneity issues.

Given that more enterprises lack investment data than intermediate input data in their actual production operations, we adopted the approach of Petrin et al. [61] to obtain consistent and efficient estimates of input factor parameters when calculating total factor productivity. The base variables utilized include the firm's operating income, net fixed assets, number of employees, and cash paid for the purchase of goods and services. The relevant data are sourced from Mark Data Network, and no modifications have been made in this paper. The detailed codes are provided in Appendix A.1.

Regarding the measurement of condition variables, this study explored the synergistic impact of seven antecedent conditions on high-quality development. Referring to the research of Liu et al. [62] and Chen et al. [63], the specific indicator selection and measurement methods are as follows: (1) R&D Investment: This study adopted a commonly used measurement method in this field, where the amount of R&D investment by the enterprise is increased by one and then the natural logarithm is taken for measurement. (2) Digital Transformation: This is a key factor affecting enterprise value creation that can promote the deep integration of digital technology and traditional production factors. Following the methodology outlined by Zhao et al. [64], the frequencies of 99 digital-related terms across four dimensions—Internet business models, modern information systems, digital application technologies, and intelligent manufacturing—are quantified and analyzed. These data are sourced from Mark Data Network and have not been altered for this study. (3) Enterprise Scale: Following the commonly used measurement method in this field, the natural logarithm of total assets was used as the measurement standard. (4) Executive Green Cognition: This mainly involves factors such as the perception of external environmental pressure, green competitive advantage cognition, and awareness of social responsibility. This was determined by selecting a series of keywords from listed company annual reports and measuring their frequency of occurrence [31]. The associated code is detailed in Appendix A.2. (5) Government Subsidies: Referring to the view of Cheng and Duan [65], this was measured by taking the natural logarithm of the government subsidy amount plus one received by an enterprise in the current year, as disclosed in the CSMAR database. (6) Market Competition: Based on the escape competition effect, stronger competition leads to lower profits, and enterprises are more likely to innovate to improve their competitive advantages. This study selected the Lerner index for measurement [66], calculated as (Enterprise Operating Revenue—Selling Expenses—Operating Costs—Administrative Expenses)/Enterprise Operating Revenue, reflecting the pricing power of the enterprise in the product market. Larger values indicate that the firm possesses greater monopoly power, possesses enhanced pricing power within the industry, and operates in a less competitive market. (7) Environmental regulations: Listed enterprises are also affected by the intensity of government environmental regulations. Based on the signaling theory, stricter government environmental regulations can release more pollution penalty signals, thereby increasing the pollution control costs of enterprises. The executive management adopts green innovation to reduce costs, thereby enabling enterprises to become legal and sustainable. However, environmental regulations also affect the spread of green ideas, thereby influencing consumer choices. Enterprises choose to provide more market-compatible products and services through green innovation. These data are sourced from Mark Data Network and have not been altered for this study. This study used Python software for the word segmentation processing of provincial government work reports, using the frequency of environmental-regulation-related words in these reports as a measurement standard [67].

3.4. Variable Calibration

This study adopted the direct calibration method, referencing the authoritative literature, to calibrate the three-dimensional antecedent conditions and outcome variables into fuzzy sets ranging from zero to one. Three anchor points were selected for each variable: 0.95, 0.5, and 0.05 quantiles, representing full membership, the crossover point (maximum fuzzy point), and full non-membership, respectively [68]. Considering that a fuzzy set membership of 0.5 cannot be included in the analysis, this study replaces it with 0.501 [69].

The variable selection, calibration anchor-point settings, and descriptive statistical results are listed in Table 2.

Table 2. Selection and calibration of variables and descriptive statistics.

Variable Classification	Variable Name	Measurement Method	Full Membership	Crossover Point	Full Non-membership	Average Value	Standard Deviation	Maximum Value	Minimum Value
Outcome Variable	Total Factor Productivity	Measured by LP method	10.320	8.349	6.909	8.432	1.005	11.144	6.352
Condition Variables	R&D Investment	The amount of R&D investment is increased by 1, and then the natural logarithm is taken.	20.989	18.371	16.494	18.501	1.348	22.665	15.689
	Digital Transformation	Digital transformation (comprehensive index)	217.000	25.000	2.000	52.365	73.466	395.000	0.000
	Enterprise Scale	Total assets (natural logarithm)	24.728	22.204	20.623	22.372	1.237	26.406	20.127
	Executive Green Cognition	Frequency of relevant words in annual reports	12.000	1.000	0.000	3.064	4.626	25.000	0.000
	Government Subsidies	Government subsidies received in the current year are increased by 1, and then the natural logarithm is taken.	19.443	16.791	14.479	16.841	1.467	20.653	12.930
	Market Competition	Lerner index	0.289	0.102	−0.047	0.108	0.107	0.402	−0.283
	Environmental Regulation	Frequency of relevant words in provincial government work reports	89.000	60.000	33.000	60.565	18.146	116.000	28.000

4. Empirical Analysis

4.1. Necessary Condition Analysis

After calibrating the data, we first conducted a necessity analysis of the individual antecedent conditions to determine the degree of dependence of the outcome variable (high-quality development) on certain antecedent condition variables. When the consistency level is greater than or equal to 0.9, the variable can be considered a necessary condition for enhancing high-quality enterprise development. Based on the panel data, the necessary condition analysis must also consider the adjusted distance within and between groups to test whether the necessary conditions have time and individual effects. When the consistency-adjusted distance is less than 0.2, the aggregate consistency accuracy is higher, providing stronger support for the results [55]. Further exploration of this necessity is required when the adjusted distance is greater than 0.2. The necessity report results for the seven antecedent conditions are listed in Table 3. The consistency levels of all variables in both the high- and non-high-quality groups were below 0.9, indicating that the seven antecedent conditions had weak independent explanatory power for the outcome variable. The occurrence of high/non-high-quality development is not dominated by a single influencing factor, and there may be interactive effects of multiple factors. Therefore, it is necessary to conduct a configurational analysis to identify the various combinations of conditions that affect high-quality enterprise development.

Table 3. Necessary condition analysis for high-quality development of high- and new-technology enterprises.

Antecedent Variables	High-Quality Development				~ High-Quality Development			
	Aggregate Consistency	Aggregate Coverage	Between-Group Consistency	Within-Group Consistency	Aggregate Consistency	Aggregate Coverage	Between-Group Consistency	Within-Group Consistency
R&D Investment	0.858	0.856	0.051	0.259	0.519	0.545	0.218	0.486
~ R&D Investment	0.544	0.518	0.174	0.486	0.863	0.865	0.051	0.227
Digital transformation	0.620	0.706	0.185	0.486	0.556	0.666	0.247	0.486
~ Digital transformation	0.706	0.602	0.163	0.454	0.754	0.677	0.073	0.454
Enterprise Scale	0.868	0.875	0.054	0.227	0.504	0.535	0.218	0.519
~ Enterprise Scale	0.539	0.508	0.149	0.486	0.882	0.876	0.036	0.227
Executive Green Cognition	0.603	0.657	0.338	0.389	0.570	0.655	0.323	0.454
~ Executive Green Cognition	0.683	0.602	0.214	0.324	0.701	0.650	0.163	0.324
Government Subsidies	0.811	0.797	0.062	0.227	0.552	0.571	0.182	0.389
~ Government Subsidies	0.564	0.545	0.145	0.421	0.804	0.817	0.036	0.259
Market Competition	0.673	0.656	0.047	0.357	0.677	0.694	0.091	0.324
~ Market Competition	0.686	0.668	0.091	0.357	0.664	0.681	0.058	0.357
Environmental Regulation	0.645	0.644	0.185	0.324	0.649	0.682	0.185	0.357
~ Environmental Regulation	0.858	0.856	0.051	0.259	0.519	0.545	0.218	0.486

Note: ~ indicates the absence of a single variable.

The between-group-consistency-adjusted distances for the antecedent conditions of government subsidies, and market competition were all less than 0.2, indicating that these conditions are not necessary for high-quality enterprise development. Other antecedent conditions had situations greater than 0.2, proving that the consistency fluctuated in the time dimension. To discuss the necessity of the remaining four antecedent conditions, it was necessary to further adjust the between-group data for annual analysis with distances greater than 0.2 for annual analysis to discuss the necessity of the remaining five antecedent conditions (Table 4). The consistency levels of antecedent variables in high/non-high states across different years were all less than 0.9, not constituting the necessary relationships in different years. Therefore, the presence or absence of all the variables does not constitute the necessary conditions for high-quality enterprise development. This research found that single antecedent conditions cannot produce high- or non-high-quality development, and further exploration of the linkage effects of different antecedent condition combinations on high-quality development is required.

Table 4. Causal combinations with between-group-consistency-adjusted distance greater than 0.2.

Causal Combination	Dimension	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
R&D Investment–~ TFP	Between-Group Consistency	0.358	0.393	0.435	0.496	0.551	0.589	0.615	0.613	0.645	0.633
	Between-Group Coverage	0.655	0.638	0.634	0.609	0.563	0.529	0.521	0.504	0.464	0.457
Enterprise Scale–~ TFP	Between-Group Consistency	0.341	0.408	0.482	0.532	0.586	0.627	0.640	0.677	0.723	0.713
	Between-Group Coverage	0.858	0.818	0.778	0.732	0.677	0.640	0.624	0.607	0.571	0.570
Executive Green Cognition–TFP	Between-Group Consistency	0.32	0.373	0.441	0.508	0.561	0.582	0.587	0.595	0.611	0.595
	Between-Group Coverage	0.612	0.615	0.626	0.600	0.552	0.524	0.512	0.496	0.459	0.450
Executive Green Cognition–~ TFP	Between-Group Consistency	0.655	0.636	0.619	0.609	0.669	0.690	0.686	0.675	0.088	0.764

	Between-Group Coverage	0.527	0.549	0.612	0.626	0.670	0.694	0.705	0.711	0.975	0.741
~ Executive Green Cognition–TFP	Between-Group Consistency	0.596	0.596	0.514	0.551	0.620	0.651	0.653	0.658	0.116	0.719
	Between-Group Coverage	0.795	0.782	0.732	0.707	0.630	0.590	0.585	0.585	0.947	0.526
~ Environmental Regulation–TFP	Between-Group Consistency	0.746	0.747	0.729	0.715	0.630	0.593	0.597	0.605	0.895	0.512
	Between-Group Coverage	0.527	0.549	0.510	0.560	0.621	0.653	0.664	0.677	0.604	0.707
~ Environmental Regulation–~ TFP	Between-Group Consistency	0.358	0.393	0.435	0.496	0.551	0.589	0.615	0.613	0.645	0.633
	Between-Group Coverage	0.358	0.393	0.435	0.496	0.551	0.589	0.615	0.613	0.645	0.633

4.2. Configurational Analysis

The QCA process must select appropriate frequency, consistency level, and proportional reduction in inconsistency (PRI) thresholds, based on the actual cases. Given the sample size of this study, the selected case frequency threshold was 20, the raw consistency threshold, 0.8, and the PRI threshold, 0.7 [68]. As there is no unified conclusion on the research of antecedent conditions influencing high-quality development, no directional hypothesis has been proposed, meaning that the presence or absence of individual antecedent conditions can contribute to high-quality development. Complex, intermediate, and parsimonious solutions were obtained using the R language. The intermediate solution was used as the main reference, and the nested relationship between parsimonious and intermediate solutions as auxiliaries, to help determine the core conditions. The configurational results obtained from the standard analysis are listed in Table 5.

Table 5. Configurational analysis results for achieving high-/non-high-quality development.

Antecedent Conditions	**High-Quality Development**			**~ High-Quality Development**				
	H1	**H2**	**H3**	**NH1**	**NH2**	**NH3**	**NH4**	**NH5**
R&D Investment	●	●	●	⊗	⊗	⊗	⊗	⊗
Digital Transformation		●		⊗				
Enterprise Scale	●	●	●	⊗	⊗	⊗	⊗	⊗
Executive Green Cognition			●		●			
Government Subsidies	●					⊗		
Market Competition		⊗					●	
Environmental Regulation			⊗					●
Consistency Level	0.933	0.958	0.949	0.941	0.946	0.935	0.956	0.941
PRI	0.864	0.876	0.856	0.872	0.872	0.871	0.886	0.858

Coverage	0.717	0.41	0.382	0.651	0.491	0.73	0.57	0.558
Unique Coverage	0.205	0.012	0.019	0.008	0.002	0.024	0.005	0.004
Between-Group Consistency Adjustment Distance	0.011	0.011	0.018	0.007	0.018	0.011	0.011	0.007
Within-Group Consistency Adjustment Distance	0.162	0.130	0.130	0.130	0.032	0.065	0.097	0.130
Overall Consistency Level	0.930			0.927				
Overall PRI	0.858			0.861				
Overall Coverage	0.757			0.800				

Note: ● = core condition present; ⓧ = core condition absent; ● = peripheral condition present; ⓧ = peripheral condition absent; blank = no impact in the configuration.

These three configuration paths can generate high-quality enterprise development. The consistency levels of the individual and overall solutions were all above the minimum acceptable standard of 0.75, with an overall consistency level of 0.930, exceeding 0.8. This indicates that the condition configurations can be viewed as sufficient for high-quality development [69], with 93% of high- and new-technology enterprises belonging to cases of relatively high-quality development. An overall coverage of 0.757 indicates that the three configurations have a high degree of explanation for high-quality development, meeting the analytical standards of dynamic QCA. The between-group and within-group consistency adjustment distances for individual configurations were all below 0.2, and the overall PRI was 0.858, indicating an 85.8% probability of avoiding the same-cause–different-outcome problem. This finding suggests that the three derived configurational paths constitute sufficient conditions for high-quality enterprise development. Observing individual configurations, the coverage of the three configurations was 0.717, 0.410, and 0.382, with relatively high consistency levels and PRI, reflecting their strong explanatory power for high-quality development cases of high- and new-technology enterprises.

Considering the distribution of each element in the configurations, R&D investment and enterprise scale were the core conditions in each configuration, forming second-order equivalent configurations. This indicates that the high-quality development of listed high- and new-technology enterprises strongly depends on R&D investment and enterprise scale. The primary factors driving high-quality development are the basic conditions of high- and new-technology enterprises, including long-term R&D investments and enterprise scale. The reasons are that, from a technological perspective, innovation is the core driving force for high-quality development of high- and new-technology enterprises. Abundant R&D investment funds can promote the application and development of new technologies and products; gradually enrich product lines; and further improve service quality, differentiation, competitiveness, reputation, and brand value, thereby driving high-quality development. From an organizational perspective, scale is a prerequisite for achieving high-quality development in high- and new-technology enterprises. Expanding scale can form economies of scale, generating further advantages and endowing enterprises with strong vitality, sustainability, and development potential. It can fully leverage the high-output and low-cost advantages of enterprise economies of scale, enhance market competitiveness and independent innovation capabilities, and build strong brands to ensure high-quality development. Under these two core conditions, three types can be categorized: multi-factor influence type, digital-technology-driven type, and green-innovation-led type. The following provides a detailed analysis of the configurations influencing the high-quality development of enterprises.

The first is the multi-factor influence type. High-quality development of high- and new-technology enterprises is linked with strong government support. It is characterized by a combination of conditions, with high R&D investment, large enterprise scale, and high government subsidies as the core conditions, collaboratively providing support for high- and new-technology enterprises at the technological, organizational, and environmental levels. Government support, through funding and policies, can create a favorable developmental environment for enterprises, stimulating their innovative vitality. Therefore, large-scale enterprises, continuous and stable R&D investment, and appropriate government support can facilitate high-quality enterprise development. The H1 configuration path covered 71.7% of the resulting cases, with approximately 20.5% of the high-quality development cases explained only by this path. This configuration incorporates elements from all three layers—technology, organization, and environment—and is named the multi-factor-driven type. This configuration has the highest raw coverage, indicating its wide applicability to most listed high- and new-technology enterprises for enhancing high-quality development.

The second type is digital-technology-driven. Configuration H2 is a combination of high R&D investment, large scale, and continuous digital transformation as core existing conditions, and fierce market competition as a core absence condition. This indicates that once the core technologies are mastered, continuous digital transformation can compensate for the deficiencies of the lack of market competition, providing a new engine for the high-quality development of listed high- and new-technology enterprises. This path accounts for approximately 41% of the cases of high-quality development. However, after excluding overlapping contributions from other configurations, the unique explanatory power of this configuration drops to just 1.2%. The effectiveness of this configuration in promoting high-quality development can be attributed to the following factors: From a market perspective, the absence of intense market competition, a core condition in this configuration, suggests that the enterprise operates in a less competitive or relatively monopolistic environment. In such a context, the enterprise should prioritize its internal development strategy. By maintaining stable R&D investment, the enterprise can sustain technological and product innovation critical for growth. Additionally, achieving a high level of digitalization enables the enterprise to transform its management model. By extending management boundaries from online to offline, it can integrate production, R&D, and other processes, thereby enhancing operational efficiency and decision-making effectiveness. This digitalization also reduces information acquisition costs and optimizes the allocation of internal resources, including talent and other critical factors, which facilitates the effective integration of business management and financial activities [70]. This helps attract high-quality R&D personnel, shorten the development cycle of new products and technologies, expand enterprise scale, and strive to exert force on both sides of the industry chain's smile curve, accelerating the rate of innovation-driven high-quality development. In other words, with digital transformation as the driving force, and in conjunction with R&D investment and enterprise scale, the absence of market competition will not become a bottleneck for high-quality development in enterprises.

The third is the green-innovation-led type. Configuration H3 is characterized by high R&D investment, large enterprise scale, and active executive green cognition as core presence conditions, with environmental regulation as the core absence condition. It indicates that even without environmental regulation, R&D investment and enterprise scale remain fundamental drivers of high-quality development in high-tech enterprises. When executives demonstrate strong green cognition, they are more likely to recognize the long-term economic and ecological advantages of pro-environmental behaviors. This is achieved through the synergistic integration of technological and organizational factors, fostering high-quality development. A horizontal comparison of Configurations H1-H3 reveals potential substitutive relationships at the technological, organizational, and environmental levels. For high-tech enterprises with high R&D investment and large scale, condition combinations such as "digital transformation and market competition flaws", "executive green cognition and environmental regulation absence", and "strong government subsidies" can serve as substitutes. Strong government subsidies offer financial support, facilitating continuous high-quality development. In the absence of market competition, high-tech enterprises, backed by substantial R&D investment and large scale, can optimize internal processes through digital transformation and other strategies to enhance efficiency and innovation, partially substituting the financial support typically provided by government subsidies. In contexts with relatively lax environmental regulations, the positive influence of executive green cognition can steer enterprises toward green development and innovation. Under certain conditions, this can compensate for the absence of government subsidies and address market competition deficiencies. Simultaneously, enterprises can capitalize on their R&D investment and scale advantages to achieve sustainable high-quality development.

Each configuration path is composed of different causal conditions, resulting in a diverse, yet convergent, relationship in the configurations of high-quality development outcomes for enterprises.

Based on the basic logic of causal asymmetry, this study identifies five configurational paths leading to non-high-quality development. Based on the distribution of various elements in the configurations, this indicates that R&D investment and enterprise scale are critical factors, whose absence forms a significant foundation for non-high-quality development, with a more universal impact. Under this premise, a comparison of the five configurations reveals that low government subsidies can be substituted by positive executive green cognition, low digital transformation, high market competition, and high environmental regulation. Further a comparison of configurations NH2, NH4, and NH5 demonstrates that even when executives exhibit strong green cognition, market competition can compel enterprises to improve efficiency and drive continuous innovation, while environmental regulation can encourage green innovation and enhance environmental performance. However, in the absence of sufficient R&D investment and scale advantages, these factors may impose additional burdens on enterprises, severely constraining their ability to achieve high-quality development.

Thus, as controllable conditions, R&D investment and enterprise scale are feasible and effective options for rapidly enhancing high-quality development. Under specific conditions, sustained investment in R&D and continuous expansion of enterprise scale can help overcome market and policy constraints. The reason is that market competition and environmental regulation appear as missing core conditions in the five configurational paths. This may be because, although enterprises may be affected by market competition and environmental regulations, they can still maintain core competitive advantages by continuously increasing R&D investment and enterprise scale, actively conducting innovative activities, and obtaining government subsidies without affecting long-term high-quality development.

4.3. Analysis of Between- and Within-Group Results

To address the limitations of traditional QCA in analyzing only cross-sectional data and comprehensively explore the time and individual effects of configurations, dynamic QCA was selected to analyze the between- and within-group consistency adjustment distances of panel data. According to Table 5, the within- and between-group consistency adjustment distances for all three configurations were not greater than 0.2, indicating no significant time or individual effects. From 2013 to 2022, the listed high- and new-technology enterprises do not follow a consistent configuration, suggesting that a particular enterprise may be suitable for more than one path to achieve high-quality development. Further investigating the changes in each configuration, Table 6 shows that the consistency levels of the three configurations fluctuate between 0.915 and 0.994, with overall small fluctuations and no significant time-varying trend. This indicates that high-quality enterprise development has strong pathway-dependent characteristics. Digital transformation and enterprise scale consistently maintain a stable impact on high-quality development across different years. Moreover, H1 and H3 showed a "collective decline" trend between 2018 and 2020, indicating that the driving paths may exhibit empowerment volatility across different periods to some extent, which may be related to major public health events causing enterprises to postpone or reduce R&D investments, temporarily impacting high-quality development and slightly reducing the explanatory power of configurational paths. However, because the between-group consistency distance was less than 0.2, it did not affect the overall explanatory power of the configurations. Notably, the consistency of Configuration H2 rebounds relatively quickly at this stage, indicating that when R&D investment and enterprise scale serve as core conditions, the positive interaction with executive green cognition enhances stability in the driving effect. This observation aligns with prior findings that "when the executive team adopts a green, high-quality development mindset, it facilitates the transition of the enterprise's development model toward sustainability". Thus, the five configurations have universality and can serve as references for listed high- and new-technology enterprises. Additionally, the between-group consistency distances were smaller than the within-group consistency distances, indicating that time effects were weaker than individual effects. Therefore, when promoting high-quality development through various configurations, attention should be paid to combining them with the actual situations of individual enterprises.

Table 6. Changes in between-group consistency.

Year	H1	H2	H3
2013	0.944	0.956	0.946
2014	0.941	0.959	0.946
2015	0.920	0.944	0.941
2016	0.915	0.945	0.944
2017	0.931	0.952	0.942
2018	0.934	0.968	0.965
2019	0.932	0.962	0.949
2020	0.928	0.965	0.945
2021	0.942	0.964	0.994
2022	0.940	0.961	0.955
Mean value	0.933	0.958	0.953
Standard deviation	0.010	0.008	0.016

4.4. Robustness Test

This study adopted the research method of Schneider and Wagemann [71] to evaluate the set relationship status and fitting parameter differences of different configurations. Robustness tests can be conducted by increasing the PRI consistency, adding or deleting cases, raising consistency, or adding other conditions. Choosing one of these methods is sufficient. If minor adjustments do not cause substantial changes in the results, the results can be considered robust. This study chose to keep other processing methods unchanged and conduct robustness tests on the analysis results by adjusting the consistency and case frequency threshold, based on the data distribution [72], as shown in Table 7. First, the consistency threshold was increased from 0.8 to 0.9, and it was found that the configurational results for high-quality development were consistent with the pre-test data. Second, the case frequency threshold was increased from 20 to 30, and no substantial difference was observed in the configurational analysis results. The configurational compositions of the baseline and adjusted models showed clear subset relationships, indicating that no substantive interpretations were required [69]. Additionally, this study employs an indicator replacement method to test the robustness of the analysis results. If parameter adjustments do not lead to substantive changes in the number, components, consistency, or coverage of the configurations, the analysis results can be considered reliable [17]. In the earlier analysis, the LP method was employed for regression calculations to obtain the total factor productivity (TFP) indicator. Similarly, the OP method is a crucial approach for calculating TFP. In this paper, the dependent variable is replaced with the TFP indicator derived using the OP method [73]. The recalibrated results confirm the same clear subset relationships observed in the previous analysis. This demonstrates that the solutions are robust and that the corresponding results and paths are rigorous and reasonable.

Table 7. Robustness test of the baseline model.

Antecedent Conditions	**Adjusting Consistency Level Threshold to 0.9**			**Adjusting Frequency Threshold to 30**		
	H1	**H2**	**H3**	**H1**	**H2**	**H3**
R&D Investment	●	●	●	●	●	●
Digital Transformation		●				●
Enterprise Scale	●	●	●	●	●	●
Executive Green Cognition			●		●	
Government Subsidies	●			●		
Market Competition		ⓧ		●		ⓧ
Environmental Regulation			ⓧ		ⓧ	•
Consistency Level	0.933	0.958	0.949	0.933	0.949	0.963
PRI	0.864	0.876	0.856	0.864	0.856	0.865
Coverage	0.717	0.41	0.382	0.717	0.382	0.331
Unique Coverage	0.205	0.012	0.019	0.205	0.019	0.010
Between-Group Consistency Adjustment Distance	0.011	0.011	0.018	0.011	0.018	0.011
Within-Group Consistency Adjustment Distance	0.162	0.130	0.130	0.162	0.130	0.130
Overall Consistency Level	0.930			0.930		
Overall PRI	0.858			0.858		
Overall Coverage	0.757			0.755		

Antecedent Conditions	Change the explained variable			
	H1	H2	H3	H4
R&D Investment	●	●	●	●

Digital Transformation		●		⊗
Enterprise Scale	●	●	●	●
Executive Green Cognition			●	
Government Subsidies	●			
Market Competition		⊗		●
Environmental Regulation			⊗	⊗
Consistency Level	0.900	0.939	0.933	0.944
PRI	0.798	0.83	0.813	0.818
Coverage	0.692	0.383	0.376	0.373
Unique Coverage	0.193	0.009	0.008	0.009
Between-Group Consistency Adjustment Distance	0.022	0.029	0.029	0.029
Within-Group Consistency Adjustment Distance	0.162	0.227	0.195	0.259
Overall Consistency Level	0.897			
Overall PRI	0.794			
Overall Coverage	0.738			

Note: ● = core condition present; ⊗ = core condition absent; • = peripheral condition present; ⊗ = peripheral condition absent; blank = no impact in the configuration.

5. Conclusions and Outlook of This Study

This study selected 1048 listed high- and new-technology enterprises in China from 2013 to 2022 as samples and employed dynamic QCA analysis to explore the multiple interactive configurational effects of the seven antecedent conditions on the high-quality development of the sample enterprises. These conditions include R&D investment and digital transformation level at the technological level, enterprise scale and executive green cognition at the organizational level, and government subsidies, market competition, and environmental regulation at the environmental level. The research results indicate the following: (1) The driving mechanism for the high-quality development of listed high- and new-technology enterprises is multifaceted. Based on the TOE framework, none of these seven antecedent factors can independently serve as necessary conditions for the high-quality development of high- and new-technology enterprises. Multiple conditions must work synergistically, and different combinations of antecedent conditions can influence high-quality enterprise development through diverse yet convergent paths. (2) Based on the sufficiency analysis of condition combinations, three configurational paths were identified, which were divided into three models: the multi-factor influence type, green-innovation-led type, and digital-technology-driven type. (3) In the necessary condition analysis, each configurational path for achieving high-quality development included R&D investment and enterprise scale. This indicates that high R&D investment and a large enterprise scale play a universal role in promoting high-quality development. Continuous R&D investment can enhance the differentiated competitive advantage and independent innovation capabilities of an enterprise, thereby enabling stable development. Further, to some extent, scale reflects the long-term financial and management conditions of an enterprise. Without these two conditions, high- and new-technology enterprises cannot achieve high-quality development. Therefore, enterprises need to strengthen their strategic scientific and technological forces and core technological breakthroughs, continuously increasing R&D investment and expanding enterprise scale. Executive green cognition, digital transformation, and government subsidies also play a core role in high-quality enterprise development, whereas insufficient R&D investment and limited enterprise scale are the core factors that cause non-high-quality development in some enterprises. (4) Although the configurations do not show significant time or individual effects, unobserved factors clearly affect some of them in certain years. The consistency of the H1 and H3 configurational solutions showed a significant decline in 2018–2020, possibly due to resource tilting caused by major public health events, leading enterprises to postpone or reduce R&D investment, thus reducing the explanatory power of the configurational paths. (5) The multi-factor-influence-driven path played an important role in promoting the development of high-quality enterprises. Green-innovation-led and digital-technology-driven configurational paths have low unique coverage and may only be suitable for some enterprises, indicating weak path dependence for high-quality development among listed high- and new-technology enterprises. Some substitutability was noted among these two paths. (6) High-quality development of listed high- and new-technology enterprises is based on an effective combination of various factors, with some differences in the importance and substitution effects of the elements. As subjectively controllable conditions, R&D investment and enterprise scale are feasible choices for rapidly and effectively enhancing high-quality enterprise development. Under specific conditions, investment in R&D technology and the continuous expansion of enterprise scale can overcome market and policy constraints. (7) With high levels of R&D investment and a large enterprise scale, the combination of "digital transformation and market competition deficiencies", the combination of "executive green cognition and the absence of environmental regulation", and government subsidies exhibit certain substitution effects, driving the high-quality development of high- and new-technology enterprises through different means to the same end. Moreover, when enterprise executives possess a high level of green cognition, they can compensate for deficiencies in environmental regulations. Furthermore, digital transformation can alleviate the dilemmas caused by competitive deficiencies in the market, providing a new engine for the high-quality development of listed high- and new-technology enterprises. (8) Market competition and environmental regulations appear to be missing core conditions on the three paths. This may be because high-quality development primarily depends on technological and internal management practices. High- and new-technology enterprises have relatively strong technological monopolies with high entry barriers, and continuous digital transformation, and are not affected by excessive market competition. Additionally, high- and new-technology enterprises possess relatively advanced environmental protection technologies, and, based on forward-looking planning, can adequately respond to any changes in environmental regulations, thus not affecting their high-quality development. (9) No time and individual effects were found; however, time effects are weaker than individual effects. This indicates that the three configurations have strong explanatory power and universal value for studying the driving factors of green innovation in high- and new-technology enterprises. When promoting high-quality development through various configurations, attention should be paid to combining them with the actual situations of individual enterprises.

Although this study has made significant contributions to the high-quality development of enterprises, several deficiencies remain that warrant further exploration in future research. First, reverse causality poses a challenge to the dynamic Qualitative Comparative Analysis (QCA) methodology. Future studies could address this issue by integrating additional quantitative research methodologies, such as regression analysis or multiple lag analysis, to better account for reverse causality. Second, to ensure the comparability of samples and enhance the depth of this study, this research primarily focused on high-tech enterprises that have been publicly listed for ten years. Future research could consider a comparative analysis of high-tech enterprises listed for less than ten years, thereby deepening the exploration of pathways to enhance the high-quality development of these firms. Furthermore, due to data accessibility constraints, this paper does not encompass the latest developments in the field. Future studies should consider expanding the time range of data to include more recent and comprehensive information. Finally, this research predominantly relies on secondary data for analysis; the findings could be further enriched and deepened through in-depth interviews, surveys, and other qualitative methods.

6. Policy Recommendations

Based on the above conclusions, this study proposes the following policy recommendations:

First, attention should be paid to multiagent collaboration. According to the analysis, no single antecedent factor is necessary, and the configurational effects among multiple conditions demonstrate the complexity of high-quality development in high- and new-technology enterprises. Enterprise managers should shift from a single-factor influence perspective and correctly assess their actual situations in various dimensions. They should not overemphasize any single key element, but strengthen deep integration and optimal allocation among various elements. Based on specific conditions, they should actively integrate resources and focus on the synergistic effects of the multiple factors behind high-quality enterprise development. This study finds that R&D investment and enterprise scale are decisive factors in high-quality development. Enterprises must fully leverage the synergistic effects of different institutional combinations through high R&D investments and effective scaled operations, prudently select targeted measures and appropriate development paths, and strive to exert economic driving effects to form effective and targeted high-quality development paths.

Second, high- and new-technology enterprises should transform their development concepts based on practical needs, shifting emphasis from “external” to “internal” factors. They must recognize that high-quality development is a long-term, dynamic, and sustainable process and that mastering core technologies is vital for gaining strength in the industry. To ensure robust and high-quality development, a dynamic adjustment mechanism for R&D investment should be established. This involves, first, making long-term, stable investments, based on existing advantages; second, adjusting the R&D investment scale to market changes, technological trends, and enterprise development strategies; third, optimizing the R&D investment structure; fourth, increasing investment in core technologies; and, finally, enhancing independent innovation capabilities in core technology areas. Enterprises must engage in industry–academia–research cooperation with universities, research institutions, and intermediary organizations. They should strengthen R&D team-building by introducing and cultivating high-quality R&D talent, improving the innovation capabilities and work efficiency of R&D personnel, addressing their shortcomings, and increasing the output efficiency of R&D investment. Simultaneously, enterprises should rationally align scale expansion with their development strategies and market demands, leveraging their scale advantages to drive innovation. They can utilize these advantages to increase their R&D investment, ensuring that the enterprise remains on an upward development trajectory.

The integration of business and finance empowers high-quality development. Digital transformation is conducive to forming an effective innovation ecosystem for high- and new-technology enterprises. Digital technologies need to be actively introduced to effectively combine business management and financial activities and applied to processes such as production, manufacturing, and strategy formulation. Establishing unified standards to optimize resource allocation allows for the maximum possible output performance from limited R&D investment, thereby consolidating the specialized and superior advantages of high- and new-technology enterprises in niche areas. Enterprises need to shoulder not only economic, but also ecological and environmental responsibilities. This study found that executive green cognition is becoming a new decisive factor in high-quality development, requiring enterprises to proactively adopt pro-environmental behaviors. Executives exert a crucial impact on high-quality enterprise development, necessitating that management personnel possess good green cognition and grasp the relevant policy directions and legal regulations in a timely manner. This can compensate for deficiencies in digital transformation, market competition, and environmental regulation. Apart from the management personnel's educational backgrounds and experience that encourage green cognition, enterprises should also innovate management methods to create a good green cultural atmosphere. While following the laws of economic and social development, the management needs to adapt to the current ecological, digital, and green external environment; integrate green development theory into corporate culture; use market mechanisms to promote enterprise green innovation levels; achieve product and market transformation; and reconstruct enterprise competitiveness.

Finally, the government should increase support for high-tech industries and provide guaranteed resources. Scattered and discontinuous government subsidies do not facilitate high-quality development. The government needs to establish and improve an integrated digital transformation public service support system, design scientific subsidy policies and programs, continuously follow up on subsidy effects, and constantly optimize them. It should increase fiscal and tax universal benefits and target support policies for high- and new-technology enterprises, such as exempting income tax on loan interest income related to innovation, fully leveraging the macroeconomic regulation role of the visible hand such that high-tech fields attract more social capital. Financial institutions and banks should be encouraged to develop exclusive financial service products for innovative enterprises and innovate financing products and guarantee methods. The government should guide enterprises to increase R&D investment, adjust R&D investment structures, cultivate their dynamic development capabilities, and innovate to drive high-quality development. R&D investment plays a crucial role, with technical R&D personnel being vital for high-quality development. Innovative human capital is indispensable to high- and new-technology enterprises. The government can adopt tax reduction or exemption measures for the personal income of technical personnel, thereby increasing the labor income of high-tech talent, enhancing their motivation, and maximizing innovative output rates. Relevant departments can also implement diverse preferential tax policies, based on different industries and regions, thereby achieving positive interactions between tax preferences and market competition, breaking information barriers, and optimizing enterprise resources. They should also promote precise assistance and balanced development of environmental-regulation-related policies, better serve the real economy, and help create a new engine for the high-quality development of high- and new-technology enterprises.

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Appendix A

Appendix A.1. LP Method for Calculating Total Factor Productivity (TFP) Code

```
* Import data
cd "F:\Mark Data Network\Listed Companies Total Factor Productivity 2000-2022"
use macrodatas_basic, clear
gen year = year_column

* Exclude financial industry and data from the IPO year and earlier
drop if regexm(industry_code, "J") | year <= real(substr(ipo_date, 1, 4))

********************** Data Processing **********************
* Handle missing values
replace depreciation_amortization = 0 if depreciation_amortization == .

* Y: Total output; K: Capital input; L: Labor input; M: Intermediate input; I: Investment
gen Y = operating_revenue / 10000
gen K = net_fixed_assets / 10000
gen L = number_of_employees
gen M = (operating_cost + selling_expenses + administrative_expenses + financial_expenses –
depreciation_amortization - cash_paid_to_employees) / 10000
gen I = cash_paid_for_fixed_assets_intangible_assets_and_other_long_term_assets / 10000

* Firm age
gen age = year - real(substr(ipo_date, 1, 4)) + 1

* State-owned enterprise dummy
gen state = ownership_nature
```

```
* Exit dummy
gen exit = (delisting_year != . | listing_status != "Normal Listing")

* Export activity dummy
gen ex = (overseas_business_income > 0)

* Define logarithmic variables
gen lnY = ln(Y + 1)
gen lnL = ln(L + 1)
gen lnM = ln(M + 1)
gen lnK = ln(K + 1)
gen lnI = ln(I + 1)

* Drop missing values
foreach i in lnY lnL lnM lnK lnI {drop if `i' == .}

* Winsorize variables
winsor2 lnY lnL lnM lnK lnI, cut(1 99) replace by(year)

* Generate province and industry variables
gen industry_code = substr(industry_code, 1, 1)
replace industry_code = substr(industry_code, 1, 2) if industry_code == "C"
encode province, gen(prov_code)

********************** Total Factor Productivity (TFP) **********************
xtset stock_code year
cap drop TFP_* _TFP*

*** LP method using levpet (requires installation). Type "help levpet" for details
levpet lnY if listing_status == "Normal Listing", free(lnL) proxy(lnM) capital(lnK)
predict _TFP_LP, omega
gen TFP_LP = ln(_TFP_LP)

sum TFP_*

cap drop _*

keep stock_code year stock_name industry_name industry_code Y K L M I TFP_LP
```

Appendix A.2. Executive Green Cognition Code

```
* Import raw data
```

```
import excel "raw_frequency_data.xlsx", sheet("Sheet1") firstrow

* Generate frequency data
egen green_cognition_total = rowtotal(energy_saving emission_reduction environmental_strategy environmental_concept environmental_management environmental_education environmental_training environmental_technology environmental_audit energy_conservation environmental_policy environmental_department environmental_inspection low_carbon environmental_work environmental_governance environmental_facilities environmental_laws environmental_pollution_control)

* Drop unnecessary variables
keep stock_code year green_cognition_total

* Generate year and code variables
gen stkcd = stock_code
gen year = year

* Drop unnecessary variables
keep stkcd year green_cognition_total

* Save data
save green_cognition_data, replace

* Merge with firm basic information
merge 1:1 stkcd year using "firm_status_info.dta", nogen keep(1 3)

* Save final data
save green_cognition_data, replace

* Export data to Excel
export excel using "green_cognition_data.xlsx", firstrow(variables) replace
```

All the codes originate from the Mark Data Network.

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