Study on the Grouping Drive of Electronic Communication Industry to Achieve High-Quality Development-Multidimensional Analysis Based on TOEI Framework

Journal:	*Science Progress*
Manuscript ID	SCI-25-1455
Manuscript Type:	Original Research Article
Date Submitted by the Author:	01-Jul-2025
Complete List of Authors:	Su, Ai; Shenyang University of Technology Song, Li; Shenyang University of Technology, Han, Liangliang; Liaoning University
Keywords:	High-Quality Development, TOEI Theoretical Framework, Necessary Condition Analysis, Fuzzy Set Qualitative Comparative Analysis, Configuration analysis
Abstract:	As a frontier field of global science and technology innovation and an important pillar in the modern economy, realizing high-quality development in the electronic communications industry is an intrinsic need to enhance the core competitiveness of enterprises. This study takes 110 electronic communication enterprises in China as research objects. Using the NCA method and the fuzzy set qualitative comparative analysis method, we explore the multifaceted group paths of electronic communication enterprises to realize high-quality development from a group perspective. Our research finds that the paths of electronic communication enterprises to achieve high-quality development can be categorized into five types. (1)The "technology-resource" co-driven type. Enterprises with strong resource management capabilities and high scientific and technological achievements output can realize high-quality development by strengthening the cultivation of scientific and technological talents and the equity incentive mechanism. (2)The "technology-led" type. For enterprises with high industry status and exemplary technological achievements, continuous improvement of technological strength is the main way to maintain competitive advantages.(3) The "talent-government" support type. For enterprises with low industry status and poor internal control quality, strong government support and scientific and technological talent cultivation can compensate for the lack of resource management capability. (4) The "resource-governance" synergy type. Regardless of industry position, excellent resource management capabilities and the quality of internal controls are central to achieving high-quality growth when equity incentive levels are low.(5) The "technology-governance" linkage type. Enterprises with high industry status and strong resource management capabilities should maintain high-quality internal controls and scientific and technological output.

Study on the Grouping Drive of Electronic Communication Industry to Achieve High-Quality Development-Multidimensional Analysis Based on TOEI Framework

Ai Su[1], Li Song[1]*, LiangLiang Han[2]

1. School of Management, Shenyang University of Technology, Shenyang 110870, Liaoning, PR China

2. School of Business, Liaoning University, Shenyang 110036, Liaoning, PR China

* Correspondence: songli@sut.edu.cn; Tel.:+86 18040019067

Abstract: As a frontier field of global science and technology innovation and an important pillar in the modern economy, realizing high-quality development in the electronic communications industry is an intrinsic need to enhance the core competitiveness of enterprises. This study takes 110 electronic communication enterprises in China as research objects. Using the NCA method and the fuzzy set qualitative comparative analysis method, we explore the multifaceted group paths of electronic communication enterprises to realize high-quality development from a group perspective. Our research finds that the paths of electronic communication enterprises to achieve high-quality development can be categorized into five types. (1)The "technology-resource" co-driven type. Enterprises with strong resource management capabilities and high scientific and technological achievements output can realize high-quality development by strengthening the cultivation of scientific and technological talents and the equity incentive mechanism. (2)The "technology-led" type. For enterprises with high industry status and exemplary technological achievements, continuous improvement of technological strength is the main way to maintain competitive advantages.(3) The "talent-government" support type. For enterprises with low industry status and poor internal control quality, strong government support and scientific and technological talent cultivation can compensate for the lack of resource management capability. (4) The "resource-governance" synergy type. Regardless of industry position, excellent resource management capabilities and the quality of internal controls are central to achieving high-quality growth when equity incentive levels are low.(5) The "technology-governance" linkage type. Enterprises with high industry status and strong resource management capabilities should maintain high-quality internal controls and scientific and technological output.

Keywords: High-Quality Development; TOEI Theoretical Framework; Necessary Condition Analysis; Fuzzy Set Qualitative Comparative Analysis; Configuration analysis

1 Introduction

Driven by global economic integration and the digital economy, the new round of scientific and technological revolutions and industrial changes provide unprecedented opportunities and challenges for countries to realize the important leap toward high-quality development. Information technology revolutionizes people's lives, business operations, and national economic growth. As a frontier field of global science and technology innovation and an important pillar in the modern economy, the level of development of the electronic communications industry largely reflects a country's economic competitiveness and industrial upgrading process (Porter & Heppelmann, 2014). In the global economic slowdown and complex and changing international environment, realizing high-quality development has become a common goal of enterprises in various countries. How different enterprises differentiate themselves to achieve quality leaps is the focus of attention of the community. China's electronics and communications industry has become a key player in the global supply chain in recent years. For example, companies such as Huawei are already global industry benchmarks. The technological catch-up experience of Chinese companies has direct relevance to developing countries. Meanwhile, the Chinese market's scale effect and complete industrial chain can provide a rich research scenario. Given this, this study analyzes the empirical methods of achieving high-quality development in China's electronic communications industry, which can help enterprises in different countries and regions learn from each other and learn from each other.

Realizing high-quality development is not the enhancement of a single capability but a systematic project with the synergy of multiple elements. Digital transformation, R&D innovation, and ESG performance all impact the quality leap of enterprise development. From the viewpoint of internal factors of enterprises, in the era of the digital economy, enterprise innovation and digital transformation have become an important way to realize the high-quality development of enterprises. It has been shown that the depth of enterprise innovation has a significant positive impact on total factor productivity, but the breadth of enterprise innovation and digital transformation has an "inverted U-shape" impact on total factor productivity (Du and Xue, 2024; Zhou et al., 2024). After an enterprise carries out R&D and innovation, IPR protection can promote the development of enterprise productivity by improving the quality of enterprise innovation, regulating fair competition in the industry, and enhancing the regional business environment (Fan et al., 2024). In addition, good ESG performance, which is synonymous with sustainable development, can help alleviate firms'ms' financing constraints and helps firms to increase R&D investment, which in turn promotes innovation output and improves innovation efficiency (Fu & Huang, 2023; Wang & Wang, 2024). Regarding external factors, some scholars have found that government subsidies encourage the establishment of new firms by comparing the total factor productivity growth rate between firms that receive government subsidies and those that do not (Harris & Li, 2019). In contrast to this finding, Barath's study proposes that different types of government subsidies have different impacts on the high quality of firms (Lajos Barάth et al., 2020; Harris & Moffat, 2020).

Currently, most academic research on the high-quality development of enterprises is conducted from a single perspective, utilizing regression analysis methods and assuming a linear relationship between causal variables (Zheng, Ulrich, K., and Javier et al., 2021). However, high-quality development combines technological progress, resource allocation efficiency improvement, and scale effect formation. It is the result of the joint action of interconnected and interacting elements. Therefore, considering the enterprises' conditions, it is necessary to explore the influence paths to improve the total factor productivity of enterprises from multiple perspectives, such as technology, organization, and environment. This study takes 110 listed enterprises in the electronic communication industry in China as the research object. The NCA method and fuzzy set qualitative comparative analysis (fsQCA) are used to explore the linkage effects of multiple concurrent factors from a group perspective. Considering each enterprise's different business characteristics, company size, and industry status, realizing high-quality development needs to be decided in the context of the enterprise's conditions. Therefore, based on the TOE theoretical framework (technology, organization, and environment), our study expands the fourth dimension of "own conditions" to construct the TOEI framework. We analyzed the necessity of the seven antecedents using the NCA and QCA methods. We found that no conditional variables are necessary to realize the high-quality development of e-communication enterprises. Through the group analysis, we found that the paths of electronic communication enterprises to achieve high-quality development can be categorized into five types, which are "technology-resource" co-driven, "technology-led," "talent-government" supportive, "talent-government" supportive, and "talent-government" supportive. The path of development can be summarized into five types: "technology-resource" co-driven type, "technology-led" type, "talent-government" support type, "resource-governance" synergy type and "technology-governance" linkage type. After analyzing the classic cases, we have summarized the types of companies suitable for each model. This helps companies choose the best approach by making precise matches according to their conditions.

The main contributions of this study are as follows: First, our findings support the predictions of TOE theory and further extend the explanatory scope and application scenarios of the TOE framework. Meanwhile, we extend the TOEI framework to the TOE theoretical framework to comprehensively capture the influence of firms' internal characteristics on TFP. Second, the study analyzes the synergistic and complementary effects among the influencing factors from a group perspective. This helps deepen scholars' understanding of the antecedent mechanisms and complex paths to achieve high-quality development. Third, our study reveals electronic communication enterprises' multiple paths and underlying logic in realizing high-quality development. It reveals that in the era of the digital economy, e-communication enterprises need to abandon the linear thinking of "technology first" or "policy dependence" and how enterprises can build a new path of compound competitive advantage through factor synergy. It provides a "capability-situation" adaptation guide for the strategic choice of enterprises to enhance total factor productivity.

2 Theoretical Framework and Model Construction

The TOE framework was initially a comprehensive analytical tool used to study the influencing factors of enterprise technology adoption from the three dimensions of technology, organization, and environment (Tornatzky et al., 1990). With the deepening research on the TOE theoretical framework, scholars have adapted the technological, organizational, and environmental conditions in the framework according to the actual situation of the research topic and the research object, and the use of the TOE framework for other areas of research has become more and more mature (Ullah F. et al., 2021; Zeng et al., 2024). In the Chinese scenario, the application of the TOE framework needs to be further refined and extended, taking into account the characteristics of Chinese business development. There have been studies that extend it to the TOEI framework (Tan et al., 2019; Xu & Li, 2024). In addition to considering the influencing factors at the technological, organizational, and environmental levels, the TFP improvement of enterprises also needs to customize the decision-making with the specific conditions of the enterprises themselves, for example, the industry status and financing ability of the enterprises. These factors are directly related to whether enterprises can effectively utilize the favorable conditions at the technological, organizational, and environmental levels and how to overcome the unfavorable conditions so as to achieve productivity improvement. Therefore, this study takes into account the development characteristics of Chinese firms in the telecommunications industry and adds the dimension of "firms' conditions" to the TOEI framework. It focuses on the interactions and synergies among the four dimensions of technology, organization, environment, and the enterprise's conditions, which is in line with the theoretical logic and practical scenarios. The research framework is shown in Figure 1.

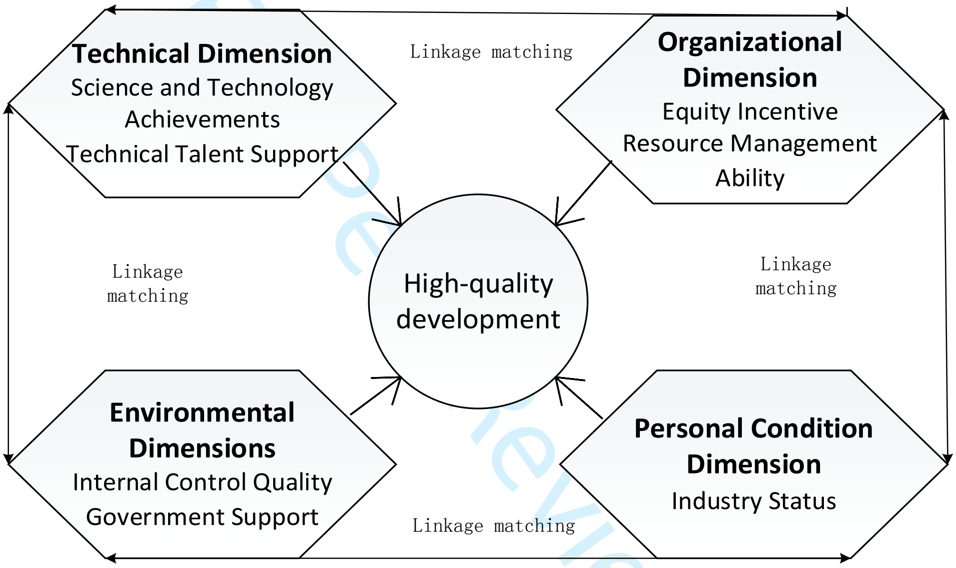

Fig.1 Theoretical framework

2.1 Technical Dimension

Electronic communications enterprises have significant technology-intensive characteristics. The quality of scientific and technological achievements and support for scientific and technological talent are the core driving forces for the sustainable development of enterprises. Technological innovation, breakthroughs, and leaps often accompany the generation of scientific and technological achievements. Technological innovation, technological upgrading, and technological diffusion promote the optimization and development of the industrial system. At the same time, scientific and technological talent is an important guarantee for the generation and transformation of scientific and technological achievements. On the one hand, high-quality talents bring cutting-edge ideas and methods to enterprises and promote the formation of a technological innovation atmosphere. On the other hand, it accelerates the transformation and application of scientific and technological achievements by promoting knowledge flow and technology diffusion. The quality of scientific and technological achievements and support for scientific and technological talent are the most representative and complementary in the technological leap of electronic communication enterprises and jointly promote the leap in the quality of development.

(1) Science and Technology Achievements

High-quality scientific and technological achievements help enterprises realize high-quality development by promoting the allocation efficiency of production factors, establishing competitive advantages, and improving the technological innovation ecosystem. First, the theory of technological innovation emphasizes the core role of technological innovation in improving the core competitiveness of enterprises and promoting economic growth. High-quality scientific and technological achievements are an important carrier of technological innovation and an important embodiment of the enterprise's continuous research and development. Generating scientific and technological achievements helps enterprises improve resource allocation efficiency and enhance the speed of transforming frontier knowledge into real productivity (Pei & Zhang, 2024). It encourages enterprises to carry out product, process, and organizational innovation continuously. Secondly, scientific and technological achievements can give enterprises a competitive advantage in a fiercely competitive market. Higher market returns will, in turn, incentivize enterprises to carry out technological innovation continuously. This positive incentive mechanism helps to form a virtuous circle. Finally, based on the knowledge spillover effect, the scientific and technological achievements of enterprises are disseminated within the industry through technological exchanges, labor mobility, market competition, etc., to establish an ecology of technological innovation within the industry, which will lead to the enhancement of productivity of the whole industry.

(2) Technical Talent Support

As the main human capital of electronic communication enterprises, technological talents provide stable support for enterprises to realize high-quality development. Existing studies have shown that technical talents have an important impact on the transformation of scientific and technological achievements in high-tech industries (Wang, 2024). Electronic communication enterprises have a high degree of specialization in all aspects of research and development, production, etc., which puts high demands on the quality of the workforce. The input of high-quality scientific and technological talents can promote the enterprise to improve the mechanism of multi-body collaborative education to stimulate the innovation potential of the enterprise as a whole. At the same time, technical talents can utilize their professional knowledge and skills to build unique technical barriers and brand advantages for enterprises. This helps to stabilize the market position and promote the development of enterprises to high value-added and high technology content areas.

2.2 Organizational Dimension

The wave of the digital economy has swept across the globe, and the pattern of resource distribution is constantly changing. In the face of a complex and changing external environment, flexible deployment of resources and refined management have become the key driving force for high-quality development. As the "operator" of the enterprise, the management is an important part of the organizational structure. Their motivation, correctness of decision-making, and resource management ability will directly affect the enterprise's overall operation. As a long-term incentive mechanism, equity incentives can not only effectively solve the principal-agent problem but also prompt management to manage the enterprise's resources accurately and maximize the use of resource value.

(1) Equity Incentive

Implementing equity incentives for management can effectively reduce agency costs, stimulate management enthusiasm, and improve the organizational and operational efficiency of the enterprise. First, based on the principal-agent theory, equity incentive effectively solves the principal-agent problem. The equity incentive mechanism can stimulate the management's sense of "ownership" and help them become good stewards who actively dedicate themselves to the operation of the enterprise. Secondly, equity incentives are also a kind of interest bundling behavior. By giving the management shares of the enterprise, their interests and long-term development are closely bound to enhance corporate cohesion and centripetal force. Third, management is an important part of the enterprise's human resources, and equity incentives can further play a resource empowerment effect. Due to the convergence of interests, the management will pay more attention to the rational allocation and efficient use of resources to enhance the overall operational efficiency of the enterprise. However, equity incentives are not the higher, the better, and some studies have shown that the effect of equity incentives on the high-quality development of enterprises presents an "inverted U-shape" (Cai & Luo, 2021).

(2) Resource Management Ability

Excellent resource management ability requires enterprise managers to have a keen insight into the market and the ability to allocate resources. Resource orchestration theory suggests that the efficient and flexible organization and use of enterprise resources are the keys to improving enterprise productivity. As an enterprise's unique resource, resource management capability is difficult to imitate and irreplaceable (Barney, 1991; Penrose, 1995). According to market changes, managers acquire new resources at the right time and realize the optimal allocation of production factors by recombining old and new resources. At the same time, refined resource management can effectively reduce the production and operation costs of the enterprise and realize cost reduction and efficiency. This helps enterprises build and maintain competitive advantages in the industry.

2.3 Environmental Dimensions

Reasonable internal control and government support are important guarantees for enterprises to realize high-quality development. From the perspective of the internal environment, an excellent corporate governance system has laid a solid foundation for the company to establish a stable and healthy business environment. A sound internal control system and strict risk management mechanism ensure the standardized operation and productivity of the enterprise. From the perspective of the external environment, the government is an important driving force in the external environment. As a provider of public resources, the government's support will directly affect the enterprise's attractiveness to the capital market and social resources.

(1) Internal Control Quality

Good internal control quality impacts high-quality development in terms of optimizing the corporate governance environment and standardizing the financial approval system. First, from the perspective of the governance environment, good internal governance, as an important institutional arrangement, helps enterprises establish a stable and healthy business environment. Based on the theory of management power, the greater the power of management, the more serious the corruption. Strict internal control, on the other hand, strengthens the supervision mechanism of the enterprise, can effectively inhibit the corruption induced by management power (Zhou et al., 2016), and drives the standardization of the enterprise's operating behavior and investment decisions. From a financial point of view, perfect internal control can reduce financial fraud, reduce the incidence of financial risks and errors, and thus protect the internal assets of the enterprise (Rapuluchukwu, 2024). From a social perspective, good internal governance can lead to market incentives (Fang & Hu, 2023; Zhang & Chen, 2024). On the one hand, due to the increased transparency of financial reporting, it is easier for enterprises to attract the trust and support of investors and financial institutions, providing financial security for enterprises' high-quality development. On the other hand, reasonable internal control helps to attract and retain excellent talents, providing powerful human resources for the R&D and innovation of enterprises.

(2) Government Support

Favorable support from the government empowers enterprises to achieve productivity leapfrogging in terms of providing financial security, easing financing constraints, and optimizing resource allocation. First, scientific and technological innovation activities, as the main business activities of electronic communication enterprises, have a greater demand for enterprise funds. Government financial support can directly reduce the financial burden of enterprises in R&D activities. Second, government support can effectively alleviate the financing constraints of enterprises so that they can avoid excessive reliance on endogenous financing (Cheng & Song,2023). Finally, based on the signaling theory, government support will send positive signals to the market, which will help to guide social capital and resources to the enterprise. The injection of new resources will motivate enterprises to optimize resource allocation and achieve higher productivity and innovation.

2.4 Personal Condition Dimension

(1) Industry Status

In the context of the information age, an enterprise's industry position in the market significantly affects its bargaining power and risk resistance. Specifically, enterprises with higher industry status usually have more substantial market influence and bargaining power. This advantage allows such firms to access resources and market share easily. They can capitalize on economies of scale. In contrast, the number of enterprises with lower industry status is much larger, and the pressure of competition is also greater. When studying the differentiated paths for electronic communication enterprises to achieve high-quality development, the impact of industry status should be fully considered to ensure the comprehensiveness and accuracy of the research results.

3 Research Design

3.1 Research Method

fsQCA follows set-theoretic and configurational logic, and its central goal is to identify combinations of conditions that are sufficient or necessary to cause a particular outcome to occur. It emphasizes interactions and synergies between conditions. There are several reasons for adopting the fsQCA method in this study:(1) Realizing high-quality development requires comprehensive analysis from multiple dimensions and perspectives. There is no linear relationship between its formative conditions and outcomes (Xue et al.,2024). fsQCA method allows scholars to stop assuming a linear causal relationship between independent and dependent variables and focus on revealing the impact of the joint action of multiple concurrent factors on the outcomes with a histogram perspective. (2) Since the actual situation of individual enterprises within the electronic communications industry varies, there is no unique path to achieve high-quality development. The fsQCA approach explores different driving paths to achieve the same result and reveals the interactions between antecedent and dependent variables and complementary substitution relationships. This helps firms to choose appropriate enhancement paths based on their characteristics. (3) When measuring the level of the antecedent variables, fsQCA can solve the problem of “absolutization” in the qualitative analysis of variables by converting the degree of affiliation of the variables into a value between 0-1.

3.2 Data Measurement

3.2.1 Sample Selection

This paper takes the electronic communication enterprises listed in China as the research object. In sample screening, A-share listed companies whose industry category is electronic communication industry are first collected from the CSMAR database and Wind database. Considering the availability and reliability of data. When screening the samples, ST, *ST, and the samples of enterprises with more missing values are excluded, and finally, 110 sample data are retained. Considering the lag in the effect of some of the antecedent variables, this paper selects the data of the antecedent variable in 2022 and the outcome variable in 2023 for analysis.

3.2.2 Variable Measurement

(1) Result Variable

High-quality development. This paper uses total factor productivity (TFP) to characterize high-quality development. As a key indicator for assessing the quality and efficiency of economic growth, total factor productivity captures the combined contribution to the output of technological progress, resource allocation efficiency, and management innovation (Solow, 1957). It can characterize the degree of high-quality development more comprehensively. The current academic research on measuring total factor productivity has been vibrant. The primary measurement methods include the OLS, the OP method (Olley et al., 1996), the LP, and the GMM methods (Balk, 2015; Balk, 2020). To further explore the accuracy of each type of method in practical application, some scholars conducted a side-by-side comparison after measuring with different methods and found that the semiparametric method was able to solve the endogeneity and sample selection problems in the traditional measurement method (Lu & Lian, 2012). Although both OP and LP methods can solve the endogeneity problem caused by the OLS method, the OP method requires enterprises to invest more than 0 in real investments, leading to many research samples being lost. Therefore, this paper adopts the LP method to measure TFP (Wang & Wang, 2024; Du and Xue, 2024; Fan et al., 2024).

(2) Conditional Variables

1） Science and Technology Achievements： Invention patents are characterized by high technical content, creativity, and complexity. When an enterprise applies for an invention patent, it must have outstanding substantive features and significant technological progress, and it can embody a breakthrough in existing technology. This paper adopts the sum of the number of inventions, utility models, and design patents that enterprises have authorized to measure scientific and technological achievements.

2）Technical Talent Support：R&D personnel is the main body of enterprise science and technology innovation activities, laying the foundation for enterprises to realize technological breakthroughs continuously. This study adopts the ratio of the number of R&D personnel to all employees as a proxy variable for technical talent support. The higher the ratio, the more technical personnel engaged in technical research and knowledge accumulation, and the stronger the technical talent support of the enterprise.

3）Equity Incentive：Management shareholding is a common indicator of the level of equity incentives implemented by a firm. A larger management shareholding indicates a stronger level of equity incentives.

4）Resource Management Ability：Resource management permeates all aspects of enterprise operations, emphasizing the efficient matching of important resources to achieve the purpose of cost reduction and efficiency. The effect of resource management will eventually be reflected in the form of profit creation and value creation for the enterprise. ROA and ROE are often used as indicators of corporate value creation in existing studies (Ji & Huang, 2022). Considering that total assets better reflect the resources owned by the enterprise, ROA is chosen to characterize the resource management ability

5）Internal Control Quality：The effect of corporate governance is a visual representation of the internal control of enterprises. ESG performance integrally reflects the results of corporate practices in the three areas of environment, society, and corporate governance. This study adopts the ratings of corporate governance dimensions in ESG disclosure to measure the level of internal control.

6）Government Support：Government subsidies can react to their support in many ways, such as financial support, risk sharing, and incentive effects. Since the R&D projects of electronic communication enterprises are characterized by greater uncertainty and the risk of R&D failure, government subsidies can not only directly increase the R&D expenditure of enterprises but also serve as a risk-sharing mechanism to increase the courage of enterprises to develop boldly. This study measures the strength of government support by the ratio of government subsidies to R&D investment, and the larger the ratio indicates, the stronger the government support.

7）Industry Status：The Lerner Index, also known as the Lerner Monopoly Power Index, is often used to measure a company's power in the market. The higher the Lerner Index of an individual stock, the stronger the market power and the higher the firm's position in the industry. Price movements of such firms can significantly impact supply and demand in the market as a whole. They can set higher prices in the market without worrying too much about the reaction of their competitors. Therefore, the Lerner index of individual stocks is chosen to characterize the industry position.

Specific variables are described in Table 1.

Table 1 Variable Description

Variable Dimension	Variable Name	Variable Symbols	Methods for Measuring Variables

Result Variable	High-quality development	*TFP*	LP Method
Technical Dimension（T）	Science and Technology Achievements	*STA*	The number of invention patents + the number of utility model patents + the number of design patents
	Technical Talent Support	*TTS*	$\frac{\text{Number of R\&D Personnel}}{\text{Total Number of Employees}}$
Organizational Dimension（O）	Equity Incentive	*EI*	$\frac{\text{Number of Shares Held by Management}}{\text{Total number of shares}}$
	Resource Management Ability	*RMA*	$\frac{\text{Net Profit}}{\text{Total Assets}}$
Environmental Dimensions（E）	Internal Control Quality	*ICQ*	ESG Rating on Corporate Governance
	Government Support	*GS*	$\frac{\text{Government Subsidies}}{\text{R\&D Investment}}$
Personal Condition Dimension（I）	Industry Status	*IS*	firm-level Lerner Index

3.2.3 Variable Calibration

Referring to existing studies (Fiss, 2007; Fiss, 2011), this paper adopts the direct calibration method to calibrate the raw data for outcome and antecedent conditions. Ragin (2008) suggests that calibration should be based on theoretical and substantive knowledge and incorporate data distribution. Quartile anchors are more robust for studying data based on the practical demands of sample size. This study draws on the mainstream practice adopted by academics (Fiss, 2007; Fiss, 2011; Tang & Huang, 2024) by setting the calibration anchors of 75%, 50%, and 10% for fully affiliated, intersected, and fully unaffiliated points, respectively. The variable calibration results are shown in Table 2.

Table 2 Variable Calibration Results and Descriptive Analysis

Variable Type	Variables	Fuzzy Set Calibration			Descriptive Analysis			
		Completely Affiliated	Crossover point	Completely Non-affiliated	Mean	Min	Max	Standard Deviation
Result Variable	*TFP*	8.771	8.219	6.926	8.203	6.192	10.740	0.922
Conditional Variables	*STA*	55.250	17.500	0.000	64.600	0.000	1250	175.131
	TTS	37.428	21.460	11.902	28.837	0.000	85.410	19.680
	EI	28.111	8.525	0.000	16.569	0.000	69.317	19.208
	RMA	0.146	0.089	-0.206	0.059	-0.758	0.462	0.206
	ICQ	7.205	6.825	5.861	6.728	5.000	7.920	0.633
	GS	0.021	0.012	0.003	0.020	0.419	0.000	0.042
	IS	0.238	0.170	0.021	0.166	-0.537	0.566	0.152

4 Data Analysis and Results

4.1 Necessary Condition Analysis

In this study, the NCA method and the QCA method were used for the necessary condition test. The QCA method starts from the set theory and determines the necessity of the antecedent condition by the consistency result. When the consistency is greater than 0.9, and the coverage is greater than 0.5, the condition variable can be regarded as necessary for the outcome variable (Fiss, 2007). The NCA method is based on the calculus perspective and contains two upper-bound estimation methods, namely, upper-bound regression (CR) and upper-bound envelopment analysis (CE). To ensure the robustness of the test results, this study presents all the computational results under the CR and CE methods. If the effect size (d-value) of the antecedent variable is not less than 0.1 and the Monte Carlo simulation replacement level of significance (P-value) exhibits significance, the antecedent condition can be judged as necessary (Dul, 2016; Vis & Dul, 2016).

The results of the NCA method analysis are shown in Table 3. Under the CR method, all the antecedent variables do not satisfy the characteristics that the effect size is not less than 0.1, and the Monte Carlo simulation replacement level of significance exhibits significance. Under the CE method, the effect size of resource management capability is greater than 0.1, and the Monte Carlo simulation replacement level of significance is significant. Considering that the variable "resource management capability" in this study is a continuous variable, the CR method is more applicable. Therefore, it was determined that all antecedent variables were not necessary for the outcome variable. Table 4 further reports the results of analyzing the bottleneck level of necessity for each antecedent variable. The results show that 9% of resource management capability, 0.3% of internal control quality, and 0.5% of industry position are required to achieve 60% of firms' total factor productivity.

Table 3 Analysis of the Necessity of Various Precedent Conditions by the NCA Method

Condition	Method	Accuracy	Ceiling Zone	Scope	d value	P value
STA	CR	100%	0.000	0.94	0.000	1.000
	CE	100%	0.000	0.94	0.000	1.000
TTS	CR	100%	0.000	0.99	0.000	0.701
	CE	100%	0.000	0.99	0.000	0.701
EI	CR	100%	0.000	0.94	0.000	1.000
	CE	100%	0.000	0.94	0.000	1.000
RMA	CR	97.3%	0.079	0.99	0.080	0.000
	CE	100%	0.104	0.99	0.105	0.000
ICQ	CR	95.5%	0.018	0.99	0.018	0.033
	CE	100%	0.007	0.99	0.007	0.217
GS	CR	99.1%	0.004	0.98	0.004	0.471
	CE	100%	0.006	0.98	0.006	0.501
IS	CR	100%	0.009	0.99	0.009	0.019
	CE	100%	0.018	0.99	0.018	0.005

Note: a. Use the calibrated fuzzy set membership degree values. d. A value of $0 \leq d < 0.1$ indicates a low level; $0.1 \leq d < 0.3$ indicates a medium level; 0.3≤d＜0.5 indicates a medium-high level; d≥0.5 indicates a high level. The number of permutation tests in NCA analysis is 10,000 times.

Table 4 Analysis of the Necessity and Bottleneck Levels (%) of Various Precedent Conditions by NCA Method

TFP	STA	TTS	EI	RMA	ICQ	GS	IS
0	NN	NN	NN	NN	NN	NN	NN
10	NN	NN	NN	NN	NN	NN	NN
20	NN	NN	NN	NN	NN	NN	NN
30	NN	NN	NN	NN	NN	NN	NN
40	NN	NN	NN	0.4	NN	NN	NN
50	NN	NN	NN	4.7	NN	NN	NN
60	NN	NN	NN	9.0	0.3	NN	0.5
70	NN	NN	NN	13.3	NN	1.4	1.4
80	NN	NN	NN	17.6	NN	4.4	2.2
90	NN	NN	NN	21.9	NN	7.3	3.1
100	NN	3.0	NN	26.2	1.8	10.2	4.0

Note: "NN" indicates that the antecedent variable is not necessary for the outcome variable.

The results of the analysis of the QCA method are shown in Table 5. The results show that the level of agreement for all the antecedent variables is less than 0.9, which does not constitute a necessary condition for the outcome variable. This result also further provides proof of NCA's previous analytical results. Since there is no necessary condition for electronic communication enterprises to achieve high-quality development, it is necessary to investigate further the impact of the joint effect of the antecedent variables on the enhancement of total factor productivity.

Table 5 Necessity Analysis of the QCA Method for Various Antecedent Conditions

Conditional Variables	High-quality development		~High-quality development	
	Consistency	Degree of coverage	Consistency	Degree of coverage
STA	0.595	0.662	0.507	0.451
~STA	0.506	0.562	0.620	0.550
TTS	0.561	0.611	0.626	0.545
~TTS	0.582	0.661	0.552	0.502
EI	0.473	0.534	0.630	0.569
~EI	0.618	0.676	0.483	0.423
RMA	0.706	0.674	0.635	0.484
~RMA	0.460	0.611	0.573	0.609
ICQ	0.630	0.650	0.576	0.475
~ICQ	0.491	0.591	0.575	0.555
GS	0.516	0.555	0.677	0.583
~GS	0.612	0.703	0.483	0.444
IS	0.627	0.647	0.611	0.504
~IS	0.520	0.626	0.572	0.551

Note: "~" represents "not".

4.2 Analysis of Configuration Results

4.2.1 Configuration Result

Referring to the mainstream practice of existing studies (Tan et al., 2019; Xue et al., 2024; Fiss, 2007; Fiss, 2011), the number of cases cutoff was set to 1, the consistency threshold was set to 0.8, and the PRI consistency threshold was set to 0.7. In the counterfactual analyses, the "present or absent" condition was set for each variable.The truth table is shown in Appendix I.

The intermediate solution was analyzed with simple counterfactuals compared to the complex solution, and the simple solution was the result after the complex counterfactual analysis was performed. This study judges the core conditions based on the intermediate solution and the simple solution to ensure that the configuration results are more realistic. The grouping path results are shown in Table 6, and the grouping analysis results are shown in Table 7.

Table 6 Conditional Configuration Paths Result

	No.	Path of Solutions	Raw Coverage	Unique Coverage	Consistency
Parsimonious Solution	1	~EI*RMA*ICQ	0.282	0.027	0.871
	2	TTS*~EI*~RMA*GS*~ICQ	0.123	0.024	0.904
	3	IS*STA*TTS*EI*~GS	0.129	0.009	0.843
	4	STA*TTS*EI*RMA*~GS	0.128	0.0007	0.871
	5	TTS*EI*RMA*GS*~ICQ	0.140	0.049	0.878
	6	STA*~TTS*~GS*ICQ	0.222	0.030	0.948
Intermediate Solution	1	STA*TTS*EI*RMA*~GS*ICQ	0.110	0.002	0.872
	2	IS*STA*TTS*EI*RMA*~GS	0.119	0.007	0.863
	3	IS*STA*TTS*EI*~GS*ICQ	0.111	0.009	0.840
	4	~STA*TTS*~EI*~RMA*GS*~ICQ	0.076	0.010	0.871
	5	~IS*TTS*~EI*~RMA*GS*~ICQ	0.107	0.017	0.925
	6	IS*TTS*EI*RMA*GS*~ICQ	0.137	0.048	0.891
	7	IS*STA*~EI*RMA*GS*ICQ	0.117	0.013	0.921
	8	~IS*~TTS*~EI*RMA*~GS*ICQ	0.122	0.006	0.975
	9	IS*STA*EI*RMA*~GS*ICQ	0.125	0.011	0.886
	10	~IS*STA*~TTS*~RMA*~GS*ICQ	0.141	0.011	0.971

Table 7 High-quality development Configuration Results

Conditional Variables	"technology-resource" co-driven type		"technology-led" type	"talent-government" support type			"resource-governance" synergy type		"technology-governance" linkage type	
	S_{1a}	S_{1b}	S_{2}	S_{3a}	S_{3b}	S_{3c}	S_{4a}	S_{4b}	S_{5a}	S_{5b}
IS		•	●		⊗	•	•	⊗	•	⊗
STA	●	●	●	⊗			•		●	●
TTS	●	●	●	●	●	●		⊗	⊗	⨂
EI	●	●	●	⨂	⨂	●	⨂	⨂	•	
RMA	●	●		⨂	⨂	●	●	●	•	⊗
ICQ	•		•	⨂	⨂	⨂	●	●	●	●
GS	⨂	⨂	⨂	●	●	●	•	⊗	⨂	⨂
Consistency	0.872	0.863	0.840	0.871	0.925	0.891	0.921	0.975	0.886	0.971
Raw coverage	0.110	0.119	0.111	0.076	0.107	0.137	0.117	0.122	0.125	0.141
Unique coverage	0.002	0.007	0.009	0.010	0.017	0.048	0.013	0.006	0.011	0.011
Solution consistency	0.856									
Solution coverage	0.594									

Note: ● indicates the presence of a core condition; • indicates the presence of a peripheral condition; ⨂ indicates the absence of a core condition; ⊗ indicates the absence of a peripheral condition; "blank" signifies that a condition may or may not be present.

4.2.2 Configuration Analysis

After the condition variables were combined in a linked fashion, 10 major grouping paths were finally formed. The overall solution's coverage is 0.594, and its consistency level is 0.856, which exceeds the initial threshold. The grouping results have strong explanatory power. Based on the existing characteristics of the core conditions, the grouping paths are named "technology-resource" co-driven type, The "technology-led" type, "talent-government" support type, "resource-governance" synergy type and "technology-governance" linkage type.

(1) "technology-resource" co-driven type（S_{1a} S_{1b}）——The development of Resource Orchestration Theory

The S_1 grouping contains two paths, S1a and S1b, with the common core conditions of high-tech achievements, high-tech talent support, high equity incentives, and high resource management capability. This means that enterprises with weak government support but strong resource management capability and high output of scientific and technological achievements can realize high-quality development by strengthening the cultivation of scientific and technological talents and implementing effective equity incentives. This path is more evident in enterprises with high industry status.

This pattern further proves the conduction mechanism of "resource combination (technical achievement + talent support) → capability construction (resource management) → value creation." It reflects the endogenously driven compensation mechanism and the dynamic capability-building path. Firstly, the synergistic effect of technological achievements and resource management makes up for the lack of external support. When the government's support is insufficient, scientific and technological achievements and technical talents, as the internal resources of the enterprise, form strategic complementarity. The reserve of scientific and technological achievements builds technical barriers for the enterprise. Strong resource management capability can accelerate the penetration of advanced technology. This further verifies the factor substitution effect in the innovation ecosystem theory, i.e., internal capability can compensate for the lack of external support. Secondly, based on the human capital theory, the enterprise's scientific and technological talents are not only the enterprise's human capital but also intellectual capital. Effective equity incentives for technology-intensive electronic communication enterprises will promote the transformation of tacit knowledge. Finally, the synergistic effect of scientific and technological achievements, talent reserve, and resource management promotes the construction of enterprise dynamic ability. The optimization of technology and the talent reserve provide absorptive capacity, and the resource management capacity provides integration and restructuring capacity.

A typical example of this configuration is China's Shengbang Co. As a leading comprehensive analog IC company in China, it has always adhered to the principle of independent product development and shaped its core professional team. The company adopts the "asset-light + R&D" model to strengthen its ability to absorb, integrate and utilize resources. Through the double helix upgrading of technology association and resource learning, the company has built an endogenous growth engine that does not rely on external policy support and has achieved high-quality development.

(2) "technology-led" type（S_2）——Validation of the technology lock-in effect

The core conditions of the S_2 grouping are high industry status, high-tech achievements, high-tech talent support, and high equity incentives. It shows that for enterprises with high industry status and exemplary scientific and technological achievements, continuous improvement of technological strength is the main way to realize high-quality development.

This grouping verifies the mechanism of creative destruction and the theory of technological path dependence. It reveals the new value-added path of technological capital in the era of the digital economy. In the electronic communication industry, enterprises with high industry status can use the economy of scale effect to form a positive feedback loop between the advantages of market power and technological strength and give full play to the cyclic effect of the “accumulation-release” of technological potential energy. Scientific and technological achievements and talent reserves build technological advantages. The advantage of the industry status will transform the technological advantage into the standard-setting right and technology diffusion barriers, which will accelerate the transformation of technological potential energy into economic value. At the same time, management is the core pillar of the enterprise, and an effective equity incentive mechanism helps to transform the core talent into “quasi-owners” to realize the maximization of the value of human capital.

A typical example of this configuration is Aiwei Electronics in China. The enterprise insists on implementing the mechanism of accumulating technological potential, forming a pool of technological reserves with high-intensity R&D investment and scientific and technological achievement output, and constructing technological barriers in niche fields. At the same time, the enterprise actively introduces domestic and foreign high-end technical talents, with the proportion of R&D personnel reaching 64.59% and the proportion of management shareholding reaching 64.16%, both of which far exceed the average level of the sample.

(3) "talent-government" support type（S_{3a} S_{3b} S_{3c}）——Refinement of the Innovation Ecosystem Theory

In the S_3 grouping, the common core conditions are high technological talent support and high government support. The S3c path shows that when high industry status exists as a secondary condition, high equity incentives, and high resource management capability are also core conditions. This suggests that for firms with low industry status and poor internal control quality, strong government support and cultivation of technological talent can compensate for the lack of resource management capability. For enterprises with high industry status but poor internal control quality, in addition to the support of the government and talents, it is also necessary to implement effective equity incentives and improve resource management ability.

This configuration reflects the compensation mechanism for resource gaps. The governance effect of “incentive-constraint-rebalancing” is achieved through risk hedging. On the one hand, enterprises with low industry status face double resource constraints. The external market bargaining power is weak, lacks scale effect, and insufficient internal resource management ability is insufficient. At this time, strong government support can directly fill the financial resource gap and reduce the trial-and-error cost of R&D and innovation. At the same time, the cultivation of scientific and technological talents can help enterprises break through the bottleneck of technological resources through the accumulation of intellectual capital. The synergistic effect of the two stimulates leveraged innovation, realizing technological catch-up and productivity improvement. On the other hand, although enterprises with high industry status have a certain degree of market dominance, deficiencies in the quality of internal control may bring about hidden dangers such as waste of resources and inefficient transformation of technological achievements.

The synergistic effect of government support and talent pool forms a risk-hedging mechanism. Governance shortcomings are compensated through capital buffers and invisible knowledge assets. At the same time, the equity incentive mechanism plays the dual role of positive incentives and implicit constraints. It inhibits short-term behavior through interest bundling, forcing management to improve resource management ability through equity dilution to minimize agency costs.

A typical example of this configuration is Allwinner Technology Co. The company is an outstanding high-performance analog device and wireless interconnect chip designer in China. The company insists on cultivating compound talents and has established a scientific, standardized, and systematic human resources training system. During its development period, the government subsidized its R&D strongly, accelerating the transformation of its technological achievements through targeted support for AIoT chip R&D, among others.

(4) "resource-governance" synergy type（S_{4a} S_{4b}）——The dampening effect of internal governance on agency costs

The common core conditions in the two groupings of category S_4 are high resource management capability, high internal control quality, and low equity incentives. In S_{4a}, high industry status, high technology achievements, and high government support are the auxiliary conditions. In S_{4b}, low industry status, low scientific and technological talent support, and low government support are the auxiliary conditions. Regardless of industry position, the ability to manage resources to maintain a high level of internal control quality is the main way to achieve high-quality growth when equity incentives are not at a high level.

This grouping reflects the endogenous driving logic of resource management and the inhibiting effect of internal governance on agency costs. First, for the enterprise as a whole, refined resource management helps the enterprise to realize the deployment and integration of old and new resources, thus promoting the transformation of technological innovation results. This will form a compensation mechanism of “efficiency instead of incentives” when equity incentives are insufficient and compensate for the lack of direct incentives for management. Secondly, reasonable internal control ensures the upgrading of resource utilization from static to dynamic through the transparency of decision-making, process standardization, and supervision normalization. Due to the technology-intensive characteristics of electronic communication enterprises, the iterative upgrading of technology is highly required. Enterprises with high-quality internal control can quickly adjust the resource allocation structure according to market changes and compensate for the delay in strategic response caused by insufficient equity incentives. Third, rigid governance and flexible resource management form a closed-loop value-added “hard governance and soft resources” system. Without the “risk-sharing” mechanism of equity incentives, strong internal control and efficient management of resources can also be controlled through risk quantification.

A typical example of this configuration is the Chinese company SangYi Technology Co. The company is a global core supplier of electronic circuit substrates. Against weak government subsidies, the company has built a dual engine of “lean operation + compliance and innovation” in copper-clad laminates using refined asset allocation and a strict internal control system. The deep synergy between resources and governance breaks through the traditional incentives and environmental constraints, verifying the core logic of “governance empowers resource efficiency.”

(5) "technology-governance" linkage type（S_{5a} S_{5b}）——Innovation paradigm of symbiotic

evolution between "Technology-Institution"

The common core conditions in the S_5 grouping are high-tech achievements, high internal control quality, and low government support. The S_{5a} grouping path shows high industry status, high equity incentives, high resource management ability, and low scientific and technological talent support as the auxiliary conditions. The S_{5b} grouping path shows low industry status and low resource management ability as the auxiliary conditions. It shows that in the case of low government support, enterprises with low industry status but with perfect corporate governance systems should focus on developing internal technology and realizing technological breakthroughs. Firms with high industry status and high resource management capability should maintain high-quality internal control and scientific and technological output to enhance their competitive advantage.

This grouping reveals the trend of two-way integration of "technology governance" and "governance technology" in the era of the digital economy. The lack of government support means enterprises have limited access to external resources. Enterprises should focus on constructing endogenous capacity, emphasizing the endogenization of innovation under resource constraints. Strict internal control guarantees the accumulation and transformation of scientific and technological achievements, and the pool of technological assets formed by scientific and technological achievements further promotes the improvement of internal governance. On the one hand, for enterprises with high industry status, equity incentives, and resource management play the function of catalysts, accelerating the penetration of technology into all production processes. On the other hand, enterprises with low industry status face the dual difficulties of limited external resources and a weak talent base. Strictly controlling the level of internal governance, screening highly feasible technology direction at the initial stage, reducing the waste of R&D resources in the middle stage through process control, and accelerating technology commercialization later to achieve technological breakthroughs.

A typical example of this configuration is the Chinese company Gore AG. The company is a globally organized technology innovation enterprise. Under the low market situation, the company makes full use of the rigidity of governance and the flexibility of technology to promote the deep integration of the two and become a "gas pedal" of technological innovation. The company strictly controls the standardization of production processes and efficiently penetrates technology into all production processes, thus achieving a quantitative to qualitative leap in productivity.

4.3 Robustness Test

The three primary methods of robustness testing include fine-tuning the calibrated anchor points, changing the case frequency cutoffs, and fine-tuning the consistency thresholds. This study's consistency threshold was 0.8 to 0.9, and PRI was 0.7 to 0.75. after performing the histogram analysis again, the results of the formed histogram analysis did not change substantially, which indicates that the study results have a high level of robustness. The results of the robustness test are presented in Appendix II.

5 Conclusion and Contribution

5.1 Conclusion

Based on the TOEI framework, this paper adopts the fsQCA method to explore the multiple grouping paths of electronic communication enterprises to realize high-quality development. The study draws the following conclusions:

First, industry status, scientific and technological achievements, scientific and technological talent support, equity incentives, resource management ability, internal control quality, and government support are not necessary for realizing high-quality development. This indicates that the independent role of individual factors cannot accomplish the leap of development quality—high-quality development results from the synergistic effect of group matching antecedent conditions.

Secondly, for electronic communication enterprises, the strategies for realizing high-quality development can be summarized into five types. (1) "Technology-resource" co-driven type. Enterprises with strong resource management capabilities and high output of scientific and technological achievements can strengthen the cultivation of scientific and technological talents and strengthen the equity incentive mechanism to achieve high-quality development. (2) "Technology-led" type. For enterprises with high industry status and exemplary scientific and technological achievements, continuous improvement of technological strength is the main way to maintain competitive advantage. (3) "Talent-government" support type. For enterprises with low industry status and poor internal control quality, strong government support and scientific and technological talent cultivation can compensate for the lack of resource management capability. For enterprises with high industry status but poor internal control quality, in addition to the government's and talents' support, it is also necessary to implement an effective equity incentive mechanism and improve resource management capabilities. (4) "Resource-governance" synergy. Regardless of industry status, maintaining a high level of internal control quality and resource management capability is the core of high-quality development when equity incentives are not high. (5) "Technology-Governance" linkage. Under low government support, enterprises with low industry status but perfect corporate governance systems should focus on developing internal technology and realizing technological breakthroughs. Enterprises with high industry status and strong resource management capabilities should maintain high-quality internal control and scientific and technological output to enhance their competitive advantages.

5.2 Contribution

The theoretical contribution of this study lies in the following three points: First, the study supports the predictions of the TOE theoretical framework. It validates the possibility of factor substitution under different dimensions. We extend the TOE framework on top of the TOE theoretical framework to comprehensively capture the linkages between the influencing factors at the technological, organizational, and environmental levels and the firm's conditions. This further extends the explanatory scope and application scenarios of the TOE framework. Second, the study findings further develop the resource orchestration theory and refine the scenario-based application of the dynamic capabilities of innovation theory. The study further empirically demonstrates the conduction mechanism of resource orchestration, capability construction, and value creation. Third, the study reveals the multiple equivalent paths and underlying logic for electronic communication enterprises to realize high-quality development, breaking through the paradigm of traditional linear analysis. The practical contribution lies in the study revealing a new path for enterprises to build compound competitive advantages through factor synergy in the digital economy era. It provides a "capability-situation" adaptation guide for the strategic formulation of high-quality development of telecommunication enterprises in various countries.

References:

[1] Balk, B.M. (2015). Measuring and relating aggregate and subaggregate total factor productivity change without neoclassical assumptions. *Statistica Neerlandica*, 69, 21 - 48. https://doi.org/10.1111/stan.12045

[2] Balk, B.M. (2020). A novel decomposition of aggregate total factor productivity change. *J Prod Anal*, 53, 95 – 105. https://doi.org/10.1007/s11123-019-00548-7

[3] Barney, J. B. . (1991). Firm resource and sustained competitive advantage. *Journal of Management*, 17(1), 99-120.https://doi.org/10.1177/014920639101700108

[4] Cai, L. , & Luo, H. . (2021). Can executive equity incentives promote high-quality development of enterprises? —— mediating effect based on innovation. *E3SWC*.https://doi.org/10.1051/e3sconf/202129202008

[5] Cheng, X.G. & Song, C.. (2023). Futures Investment, Financing Constraints and Enterprise Total Factor Productivity.*Jiang-huai Tribune*(05),39-48.https://doi.org/10.16064/j.cnki.cn34-1003/g0.2023.05.011.

[6] Di, C.Z. & Xue, Y.Z.. (2024). R&D Alliance, Open Innovation and Enterprise Total Factor Productivity Growth.*Journal of Quantitative & Technological Economics*(12),111-132.https://doi.org/10.13653/j.cnki.jqte.20240926.005.

[7] Dul, J. (2016). Identifying single necessary conditions with NCA and fsQCA. *Journal of Business Research*, 69, 1516-1523.https://doi.org/10.1016/j.jbusres.2015.10.134

[8] Fan, H. , Yin, J. , Usman, M. , & Li, Z. . (2024). Intellectual property protection and total factor productivity of enterprises: a quasi-natural experiment of intellectual property courts. *Finance Research Letters*, 70.https://doi.org/10.1016/j.frl.2024.106236

[9] Fang, X.M. & Hu, D.. (2023). Corporate ESG Performance and Innovation:Empirical Evidence from A-share Listed Companies.*Economic Research Journal*(02),91-106.https://d.wanfangdata.com.cn/periodical/jjyj202302007

[10] Fiss, P. C. . (2007). A set-theoretic approach to organizational configurations. *The Academy of Management Review*, 32(4), 1180-1198.https://doi.org/10.5465/AMR.2007.26586092

[11] Fiss, P. C. . (2011). Building Better Causal Theories: A Fuzzy Set Approach to Typologies in Organization Research. *Academy of Management Journal*, 54(2), 393-420.https://doi.org/10.5465/amj.2011.60263120

[12] Fu, J.L. & Huang, X.H.. (2023). How Does ESG Performance Affect the Total Factor Productivity of Enterprises?.*Economic Survey*(03),108-117.https://doi.org/10.15931/j.cnki.1006-1096.2023.03.010.

[13] Harris, R. & Li, S.Y. (2019). Government assistance and total factor productivity: Firm-level evidence from China. *Journal of Productivity Analysis*, 52, 1-27.https://doi.org/10.1007/s11123-019-00559-4

[14] Harris, R.D., & Moffat, J. (2020). The Impact of Product Subsidies on Plant - Level Total Factor Productivity in Britain, 1997 - 2014. *Political Economy: Taxation*. https://doi.org/10.1111/sjpe.12240

[15] Ji, X.X. & Huang, M.. (2022). Digital Level and Enterprise Value: An Empirical Study from the Perspective of Resource Orchestration.*Modern Economic Research*(04),105-113.https://doi.org/10.3969/j.issn.1009-2382.2022.04.011

[16] Lajos Baráth, Fert, I. , & Bojnec, T. . (2020). The effect of investment, lfa and agri e nvironmental subsidies on the components of total factor productivity: the case of slovenian farms. *Journal of Agricultural Economics*.https://doi.org/10.1111/1477-9552.12374

[17] Levinsohn, J., & Petrin, A. (2003). Estimating production functions using inputs to control for unobservables. *Review of Economic Studies*, 70(2), 317-341. https://doi.org/10.1111/1467-937X.00246

[18] Lu, X.D. & Lian, Y.J.. (2012). Estimation of Total Factor Productivity of Industrial Enterprises in China: 1999—2007.*China Economic Quarterly*(02),541-558.https://doi.org/10.13821/j.cnki.ceq.2012.02.013.

[19] Olley, G. S. , & Pakes, A. (1996). The dynamics of productivity in the telecommunications equipment industry. *Social Science Electronic Publishing*.https://doi.org/10.3386/W3977

[20] Pei, X. & Zhang, M.Z.. (2024). Research on the Improvement Paths of Total Factor Productivity for the Specialized and Sophisticated Enterprises Under the Perspective of Configuration.*Science and Technology Management Research*, 44(17), 10-17.https://doi.org/10.3969/j.issn.1000-7695.2024.17.002

[21] Penrose, E. . (1995). The theory of the growth of the firm. *Long Range Planning*, 29(4), 1.https://doi.org/10.1016/S0024-6301(96)90295-2

[22] Porter, M.E., & Heppelmann, J.E. (2014). How Smart, Connected Products Are Transforming Competition. *Harvard Business Review*, 92, 18.

[23] Rapuluchukwu Peter Igbojioyibo.(2024).The Impact of Internal Control Systems on Asset Protection and Financial Reporting Accuracy in SMEs.*Asian Journal of Economics, Business and Accounting*(12),65-80.https://doi.org/10.9734/AJEBA/2024/V24I121592

[24] Solow, R.M. (1957) Technical Change and the Aggregate Production Function. Review of Economics and Statistics. *The Review of Economics and Statistics*, 39, 312-320.https://doi.org/10.2307/1926047

[25] Tan, H.B., Fan, Z.T. & Du, Y.Z.. (2019). Technology Management Capability, Attention Distribution and Local Government Website Construction:A Configurational Analysis Based on the TOE Framework.*Journal of Management World*(09),81-94.https://doi.org/10.19744/j.cnki.11-1235/f.2019.0119.

[26] Tornatzky, L. G. , Fleischer, M. , & Chakrabarti, A. K. . (1990). processes of technological innovation. *Lexington Books*. https://www.researchgate.net/publication/291824703_Technological_Innovation_as_a_Process

[27] Ullah, F., Qayyum, S., Thaheem, M.J., Al-turjman, F.M., & Sepasgozar, S.M. (2021). Risk management in sustainable smart cities governance: A TOE framework. *Technological Forecasting and Social Change*, 167, 120743.https://doi.org/10.1016/J.TECHFORE.2021.120743

[28] Vis, B., & Dul, J. (2018). Analyzing Relationships of Necessity Not Just in Kind But Also in Degree: Complementing fsQCA With NCA. *Sociological methods & research*, 47(4),

872－899. https://doi.org/10.1177/0049124115626179

[29] Wang, S.X. & Wang, Z.M.. (2023). Corporate ESG Performance,Innovation and Total Factor Productivity.*Macroeconomics*(11),62-74.https://doi.org/10.16304/j.cnki.11-3952/f.2023.11.009.

[30] Wang, X.. (2024). Research on the transformation configuration of S&T achievements in high-tech industries under the TOE framework.Science *Research Management*(06),164-173.https://doi.org/10.19571/j.cnki.1000-2995.2024.06.017.

[31] Xu, Y.H. & Li, W.C.. (2024). Research on the Mobilization Mechanism of Primary-Level Governance in Digital Society: From TOE to TOEI.*Jilin University Journal Social Sciences Edition*(04),219-234+240.https://doi.org/10.15939/j.jujsse.2024.04.sh2.

[32] Xue, Y.X., Zhang, J.C., Zhang, Y.& Yu, X.Y.. (2024). Research on the linkage path of high-quality development of Chinese manufacturing enterprises.*Science Research Management*(07),29-39.https://doi.org/10.19571/j.cnki.1000-2995.2024.07.004.

[33] Zhang, S.F. & Chen, Y.Q.. (2024). Study on the improvement path of innovation performance of "SRDI" small and medium-sized enterprises.*Studies in Science of Science*, 42(4), 873-884.https://doi.org/10.16192/j.cnki.1003-2053.20230419.001

[34] Zhang, S.S. & Chen, K.X.. (2024). Corporate ESG Performance and Digital Technology Innovation.*Collected Essays on Finance and Economics*(09),69-79.https://doi.org/10.13762/j.cnki.cjlc.20240709.002.

[35] Zeng, J.W., Li, B.Z., Song, P. & Wang, X.. (2023). The Driving Path of Enterprise Original Innovation:A Configuration Analysis Based on TOE Framework.*Science & Technology Progress and Policy*(01),71-80.

[36] Zheng, L. , Ulrich, K. , & Javier Sendra-García. (2021). Qualitative comparative analysis: configurational paths to innovation performance. *Journal of Business Research*, 128(3), 83-93.https://doi.org/10.1016/j.jbusres.2021.01.044

[37] Zhou, M.H., Lin, B. & Lin, D.J.. (2016). Management Power,Internal Control and Corruption Governance.*Accounting Research*(03),56-63+96.https://doi.org/10.3969/j.issn.1003-2886.2016.03.008

[38] Zhou, W.H., Li, M.Y. & Li, Y.N.. (2024). Digital Transformation, Total Factor Productivity and Enterprise Value Creation.*Statistics & Decision*(16),178-182.https://doi.org/10.13546/j.cnki.tjyjc.2024.16.032.

Study on the Grouping Drive of Electronic Communication Industry to Achieve High-Quality Development-Multidimensional Analysis Based on TOEI Framework

Abstract: As a frontier field of global science and technology innovation and an important pillar in the modern economy, realizing high-quality development in the electronic communications industry is an intrinsic need to enhance the core competitiveness of enterprises. This study takes 110 electronic communication enterprises in China as research objects. Using the NCA method and the fuzzy set qualitative comparative analysis method, we explore the multifaceted group paths of electronic communication enterprises to realize high-quality development from a group perspective. Our research finds that the paths of electronic communication enterprises to achieve high-quality development can be categorized into five types. (1)The "technology-resource" co-driven type. Enterprises with strong resource management capabilities and high scientific and technological achievements output can realize high-quality development by strengthening the cultivation of scientific and technological talents and the equity incentive mechanism. (2)The "technology-led" type. For enterprises with high industry status and exemplary technological achievements, continuous improvement of technological strength is the main way to maintain competitive advantages.(3) The "talent-government" support type. For enterprises with low industry status and poor internal control quality, strong government support and scientific and technological talent cultivation can compensate for the lack of resource management capability. (4) The "resource-governance" synergy type. Regardless of industry position, excellent resource management capabilities and the quality of internal controls are central to achieving high-quality growth when equity incentive levels are low.(5) The "technology-governance" linkage type. Enterprises with high industry status and strong resource management capabilities should maintain high-quality internal controls and scientific and technological output.

Keywords: High-Quality Development; TOEI Theoretical Framework; Necessary Condition Analysis; Fuzzy Set Qualitative Comparative Analysis; Configuration analysis

1 Introduction

Driven by global economic integration and the digital economy, the new round of scientific and technological revolutions and industrial changes provide unprecedented opportunities and challenges for countries to realize the important leap toward high-quality development. Information technology revolutionizes people's lives, business operations, and national economic growth. As a frontier field of global science and technology innovation and an important pillar in the modern economy, the level of development of the electronic communications industry largely reflects a country's economic competitiveness and industrial upgrading process (Porter & Heppelmann, 2014). In the global economic slowdown and complex and changing international environment, realizing high-quality development has become a common goal of enterprises in various countries. How different enterprises differentiate themselves to achieve quality leaps is the focus of attention of the community. China's electronics and communications industry has become a key player in the global supply chain in recent years. For example, companies such as Huawei are already global industry benchmarks. The technological catch-up experience of Chinese companies has direct relevance to developing countries. Meanwhile, the Chinese market's scale effect and complete industrial chain can provide a rich research scenario. Given this, this study analyzes the empirical methods of achieving high-quality development in China's electronic communications industry, which can help enterprises in different countries and regions learn from each other and learn from each other.

Realizing high-quality development is not the enhancement of a single capability but a systematic project with the synergy of multiple elements. Digital transformation, R&D innovation, and ESG performance all impact the quality leap of enterprise development. From the viewpoint of internal factors of enterprises, in the era of the digital economy, enterprise innovation and digital transformation have become an important way to realize the high-quality development of enterprises. It has been shown that the depth of enterprise innovation has a significant positive impact on total factor productivity, but the breadth of enterprise innovation and digital transformation has an "inverted U-shape" impact on total factor productivity (Du and Xue, 2024; Zhou et al., 2024). After an enterprise carries out R&D and innovation, IPR protection can promote the development of enterprise productivity by improving the quality of enterprise innovation, regulating fair competition in the industry, and enhancing the regional business environment (Fan et al., 2024). In addition, good ESG performance, which is synonymous with sustainable development, can help alleviate firms'ms' financing constraints and helps firms to increase R&D investment, which in turn promotes innovation output and improves innovation efficiency (Fu & Huang, 2023; Wang & Wang, 2024). Regarding external factors, some scholars have found that government subsidies encourage the establishment of new firms by comparing the total factor productivity growth rate between firms that receive government subsidies and those that do not (Harris & Li, 2019). In contrast to this finding, Barath's study proposes that different types of government subsidies have different impacts on the high quality of firms (Lajos Baráth et al., 2020; Harris & Moffat, 2020).

Currently, most academic research on the high-quality development of enterprises is conducted from a single perspective, utilizing regression analysis methods and assuming a linear relationship between causal variables (Zheng, Ulrich, K., and Javier et al., 2021). However, high-quality development combines technological progress, resource allocation efficiency improvement, and scale effect formation. It is the result of the joint action of interconnected and interacting elements. Therefore, considering the enterprises' conditions, it is necessary to explore the influence paths to improve the total factor productivity of enterprises from multiple perspectives, such as technology, organization, and environment. This study takes 110 listed enterprises in the electronic communication industry in China as the research object. The NCA method and fuzzy set qualitative comparative analysis (fsQCA) are used to explore the linkage effects of multiple concurrent factors from a group perspective. Considering each enterprise's different business characteristics, company size, and industry status, realizing high-quality development needs to be decided in the context of the enterprise's conditions. Therefore, based on the TOE theoretical framework (technology, organization, and environment), our study expands the fourth dimension of "own conditions" to construct the TOEI framework. We analyzed the necessity of the seven antecedents using the NCA and QCA methods. We found that no conditional variables are necessary to realize the high-quality development of e-communication enterprises. Through the group analysis, we found that the paths of electronic communication enterprises to achieve high-quality development can be categorized into five types, which are "technology-resource" co-driven, "technology-led," "talent-government" supportive, "talent-government" supportive, and "talent-government" supportive. The path of development can be summarized into five types: "technology-resource" co-driven type, "technology-led" type, "talent-government" support type, "resource-governance" synergy type and "technology-governance" linkage type. After analyzing the classic cases, we have summarized the types of companies suitable for each model. This helps companies choose the best approach by making precise matches according to their conditions.

The main contributions of this study are as follows: First, our findings support the predictions of TOE theory and further extend the explanatory scope and application scenarios of the TOE framework. Meanwhile, we extend the TOEI framework to the TOE theoretical framework to comprehensively capture the influence of firms' internal characteristics on TFP. Second, the study analyzes the synergistic and complementary effects among the influencing factors from a group perspective. This helps deepen scholars' understanding of the antecedent mechanisms and complex paths to achieve high-quality development. Third, our study reveals electronic communication enterprises' multiple paths and underlying logic in realizing high-quality development. It reveals that in the era of the digital economy, e-communication enterprises need to abandon the linear thinking of "technology first" or "policy dependence" and how enterprises can build a new path of compound competitive advantage through factor synergy. It provides a "capability-situation" adaptation guide for the strategic choice of enterprises to enhance total factor productivity.

2 Theoretical Framework and Model Construction

The TOE framework was initially a comprehensive analytical tool used to study the influencing factors of enterprise technology adoption from the three dimensions of technology, organization, and environment (Tornatzky et al., 1990). With the deepening research on the TOE theoretical framework, scholars have adapted the technological, organizational, and environmental conditions in the framework according to the actual situation of the research topic and the research object, and the use of the TOE framework for other areas of research has become more and more mature (Ullah F. et al., 2021; Zeng et al., 2024). In the Chinese scenario, the application of the TOE framework needs to be further refined and extended, taking into account the characteristics of Chinese business development. There have been studies that extend it to the TOEI framework (Tan et al., 2019; Xu & Li, 2024). In addition to considering the influencing factors at the technological, organizational, and environmental levels, the TFP improvement of enterprises also needs to customize the decision-making with the specific conditions of the enterprises themselves, for example, the industry status and financing ability of the enterprises. These factors are directly related to whether enterprises can effectively utilize the favorable conditions at the technological, organizational, and environmental levels and how to overcome the unfavorable conditions so as to achieve productivity improvement. Therefore, this study takes into account the development characteristics of Chinese firms in the telecommunications industry and adds the dimension of "firms' conditions" to the TOEI framework. It focuses on the interactions and synergies among the four dimensions of technology, organization, environment, and the enterprise's conditions, which is in line with the theoretical logic and practical scenarios. The research framework is shown in Figure 1.

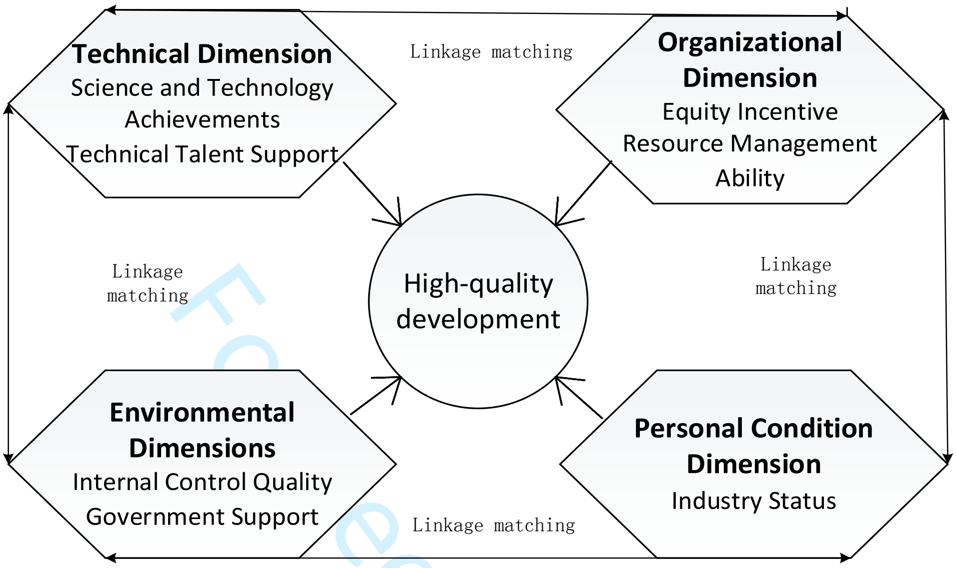

Fig.1 Theoretical framework

2.1 Technical Dimension

Electronic communications enterprises have significant technology-intensive characteristics. The quality of scientific and technological achievements and support for scientific and technological talent are the core driving forces for the sustainable development of enterprises. Technological innovation, breakthroughs, and leaps often accompany the generation of scientific and technological achievements. Technological innovation, technological upgrading, and technological diffusion promote the optimization and development of the industrial system. At the same time, scientific and technological talent is an important guarantee for the generation and transformation of scientific and technological achievements. On the one hand, high-quality talents bring cutting-edge ideas and methods to enterprises and promote the formation of a technological innovation atmosphere. On the other hand, it accelerates the transformation and application of scientific and technological achievements by promoting knowledge flow and technology diffusion. The quality of scientific and technological achievements and support for scientific and technological talent are the most representative and complementary in the technological leap of electronic communication enterprises and jointly promote the leap in the quality of development.

(1) Science and Technology Achievements

High-quality scientific and technological achievements help enterprises realize high-quality development by promoting the allocation efficiency of production factors, establishing competitive advantages, and improving the technological innovation ecosystem. First, the theory of technological innovation emphasizes the core role of technological innovation in improving the core competitiveness of enterprises and promoting economic growth. High-quality scientific and technological achievements are an important carrier of technological innovation and an important embodiment of the enterprise's continuous research and development. Generating scientific and technological achievements helps enterprises improve resource allocation efficiency and enhance the speed of transforming frontier knowledge into real productivity (Pei & Zhang, 2024). It encourages enterprises to carry out product, process, and organizational innovation continuously. Secondly, scientific and technological achievements can give enterprises a competitive advantage in a fiercely competitive market. Higher market returns will, in turn, incentivize enterprises to carry out technological innovation continuously. This positive incentive mechanism helps to form a virtuous circle. Finally, based on the knowledge spillover effect, the scientific and technological achievements of enterprises are disseminated within the industry through technological exchanges, labor mobility, market competition, etc., to establish an ecology of technological innovation within the industry, which will lead to the enhancement of productivity of the whole industry.

(2) Technical Talent Support

As the main human capital of electronic communication enterprises, technological talents provide stable support for enterprises to realize high-quality development. Existing studies have shown that technical talents have an important impact on the transformation of scientific and technological achievements in high-tech industries (Wang, 2024). Electronic communication enterprises have a high degree of specialization in all aspects of research and development, production, etc., which puts high demands on the quality of the workforce. The input of high-quality scientific and technological talents can promote the enterprise to improve the mechanism of multi-body collaborative education to stimulate the innovation potential of the enterprise as a whole. At the same time, technical talents can utilize their professional knowledge and skills to build unique technical barriers and brand advantages for enterprises. This helps to stabilize the market position and promote the development of enterprises to high value-added and high technology content areas.

2.2 Organizational Dimension

The wave of the digital economy has swept across the globe, and the pattern of resource distribution is constantly changing. In the face of a complex and changing external environment, flexible deployment of resources and refined management have become the key driving force for high-quality development. As the "operator" of the enterprise, the management is an important part of the organizational structure. Their motivation, correctness of decision-making, and resource management ability will directly affect the enterprise's overall operation. As a long-term incentive mechanism, equity incentives can not only effectively solve the principal-agent problem but also prompt management to manage the enterprise's resources accurately and maximize the use of resource value.

(1) Equity Incentive

Implementing equity incentives for management can effectively reduce agency costs, stimulate management enthusiasm, and improve the organizational and operational efficiency of the enterprise. First, based on the principal-agent theory, equity incentive effectively solves the principal-agent problem. The equity incentive mechanism can stimulate the management's sense of "ownership" and help them become good stewards who actively dedicate themselves to the operation of the enterprise. Secondly, equity incentives are also a kind of interest bundling behavior. By giving the management shares of the enterprise, their interests and long-term development are closely bound to enhance corporate cohesion and centripetal force. Third, management is an important part of the enterprise's human resources, and equity incentives can further play a resource empowerment effect. Due to the convergence of interests, the management will pay more attention to the rational allocation and efficient use of resources to enhance the overall operational efficiency of the enterprise. However, equity incentives are not the higher, the better, and some studies have shown that the effect of equity incentives on the high-quality development of enterprises presents an "inverted U-shape" (Cai & Luo, 2021).

(2) Resource Management Ability

Excellent resource management ability requires enterprise managers to have a keen insight into the market and the ability to allocate resources. Resource orchestration theory suggests that the efficient and flexible organization and use of enterprise resources are the keys to improving enterprise productivity. As an enterprise's unique resource, resource management capability is difficult to imitate and irreplaceable (Barney, 1991; Penrose, 1995). According to market changes, managers acquire new resources at the right time and realize the optimal allocation of production factors by recombining old and new resources. At the same time, refined resource management can effectively reduce the production and operation costs of the enterprise and realize cost reduction and efficiency. This helps enterprises build and maintain competitive advantages in the industry.

2.3 Environmental Dimensions

Reasonable internal control and government support are important guarantees for enterprises to realize high-quality development. From the perspective of the internal environment, an excellent corporate governance system has laid a solid foundation for the company to establish a stable and healthy business environment. A sound internal control system and strict risk management mechanism ensure the standardized operation and productivity of the enterprise. From the perspective of the external environment, the government is an important driving force in the external environment. As a provider of public resources, the government's support will directly affect the enterprise's attractiveness to the capital market and social resources.

(1) Internal Control Quality

Good internal control quality impacts high-quality development in terms of optimizing the corporate governance environment and standardizing the financial approval system. First, from the perspective of the governance environment, good internal governance, as an important institutional arrangement, helps enterprises establish a stable and healthy business environment. Based on the theory of management power, the greater the power of management, the more serious the corruption. Strict internal control, on the other hand, strengthens the supervision mechanism of the enterprise, can effectively inhibit the corruption induced by management power (Zhou et al., 2016), and drives the standardization of the enterprise's operating behavior and investment decisions. From a financial point of view, perfect internal control can reduce financial fraud, reduce the incidence of financial risks and errors, and thus protect the internal assets of the enterprise (Rapuluchukwu, 2024). From a social perspective, good internal governance can lead to market incentives (Fang & Hu, 2023; Zhang & Chen, 2024). On the one hand, due to the increased transparency of financial reporting, it is easier for enterprises to attract the trust and support of investors and financial institutions, providing financial security for enterprises' high-quality development. On the other hand, reasonable internal control helps to attract and retain excellent talents, providing powerful human resources for the R&D and innovation of enterprises.

(2) Government Support

Favorable support from the government empowers enterprises to achieve productivity leapfrogging in terms of providing financial security, easing financing constraints, and optimizing resource allocation. First, scientific and technological innovation activities, as the main business activities of electronic communication enterprises, have a greater demand for enterprise funds. Government financial support can directly reduce the financial burden of enterprises in R&D activities. Second, government support can effectively alleviate the financing constraints of enterprises so that they can avoid excessive reliance on endogenous financing (Cheng & Song,2023). Finally, based on the signaling theory, government support will send positive signals to the market, which will help to guide social capital and resources to the enterprise. The injection of new resources will motivate enterprises to optimize resource allocation and achieve higher productivity and innovation.

2.4 Personal Condition Dimension

(1) Industry Status

In the context of the information age, an enterprise's industry position in the market significantly affects its bargaining power and risk resistance. Specifically, enterprises with higher industry status usually have more substantial market influence and bargaining power. This advantage allows such firms to access resources and market share easily. They can capitalize on economies of scale. In contrast, the number of enterprises with lower industry status is much larger, and the pressure of competition is also greater. When studying the differentiated paths for electronic communication enterprises to achieve high-quality development, the impact of industry status should be fully considered to ensure the comprehensiveness and accuracy of the research results.

3 Research Design

3.1 Research Method

fsQCA follows set-theoretic and configurational logic, and its central goal is to identify combinations of conditions that are sufficient or necessary to cause a particular outcome to occur. It emphasizes interactions and synergies between conditions. There are several reasons for adopting the fsQCA method in this study:(1) Realizing high-quality development requires comprehensive analysis from multiple dimensions and perspectives. There is no linear relationship between its formative conditions and outcomes (Xue et al.,2024). fsQCA method allows scholars to stop assuming a linear causal relationship between independent and dependent variables and focus on revealing the impact of the joint action of multiple concurrent factors on the outcomes with a histogram perspective. (2) Since the actual situation of individual enterprises within the electronic communications industry varies, there is no unique path to achieve high-quality development. The fsQCA approach explores different driving paths to achieve the same result and reveals the interactions between antecedent and dependent variables and complementary substitution relationships. This helps firms to choose appropriate enhancement paths based on their characteristics. (3) When measuring the level of the antecedent variables, fsQCA can solve the problem of "absolutization" in the qualitative analysis of variables by converting the degree of affiliation of the variables into a value between 0-1.

3.2 Data Measurement

3.2.1 Sample Selection

This paper takes the electronic communication enterprises listed in China as the research object. In sample screening, A-share listed companies whose industry category is electronic communication industry are first collected from the CSMAR database and Wind database. Considering the availability and reliability of data. When screening the samples, ST, *ST, and the samples of enterprises with more missing values are excluded, and finally, 110 sample data are retained. Considering the lag in the effect of some of the antecedent variables, this paper selects the data of the antecedent variable in 2022 and the outcome variable in 2023 for analysis.

3.2.2 Variable Measurement

(1) Result Variable

High-quality development. This paper uses total factor productivity (TFP) to characterize high-quality development. As a key indicator for assessing the quality and efficiency of economic growth, total factor productivity captures the combined contribution to the output of technological progress, resource allocation efficiency, and management innovation (Solow, 1957). It can characterize the degree of high-quality development more comprehensively. The current academic research on measuring total factor productivity has been vibrant. The primary measurement methods include the OLS, the OP method (Olley et al., 1996), the LP, and the GMM methods (Balk, 2015; Balk, 2020). To further explore the accuracy of each type of method in practical application, some scholars conducted a side-by-side comparison after measuring with different methods and found that the semiparametric method was able to solve the endogeneity and sample selection problems in the traditional measurement method (Lu & Lian, 2012). Although both OP and LP methods can solve the endogeneity problem caused by the OLS method, the OP method requires enterprises to invest more than 0 in real investments, leading to many research samples being lost. Therefore, this paper adopts the LP method to measure TFP (Wang & Wang, 2024; Du and Xue, 2024; Fan et al., 2024).

(2) Conditional Variables

1）Science and Technology Achievements： Invention patents are characterized by high technical content, creativity, and complexity. When an enterprise applies for an invention patent, it must have outstanding substantive features and significant technological progress, and it can embody a breakthrough in existing technology. This paper adopts the sum of the number of inventions, utility models, and design patents that enterprises have authorized to measure scientific and technological achievements.

2）Technical Talent Support： R&D personnel is the main body of enterprise science and technology innovation activities, laying the foundation for enterprises to realize technological breakthroughs continuously. This study adopts the ratio of the number of R&D personnel to all employees as a proxy variable for technical talent support. The higher the ratio, the more technical personnel engaged in technical research and knowledge accumulation, and the stronger the technical talent support of the enterprise.

3）Equity Incentive：Management shareholding is a common indicator of the level of equity incentives implemented by a firm. A larger management shareholding indicates a stronger level of equity incentives.

4）Resource Management Ability：Resource management permeates all aspects of enterprise operations, emphasizing the efficient matching of important resources to achieve the purpose of cost reduction and efficiency. The effect of resource management will eventually be reflected in the form of profit creation and value creation for the enterprise. ROA and ROE are often used as indicators of corporate value creation in existing studies (Ji & Huang, 2022). Considering that total assets better reflect the resources owned by the enterprise, ROA is chosen to characterize the resource management ability.

5）Internal Control Quality：The effect of corporate governance is a visual representation of the internal control of enterprises. ESG performance integrally reflects the results of corporate practices in the three areas of environment, society, and corporate governance. This study adopts the ratings of corporate governance dimensions in ESG disclosure to measure the level of internal control.

6）Government Support：Government subsidies can react to their support in many ways, such as financial support, risk sharing, and incentive effects. Since the R&D projects of electronic communication enterprises are characterized by greater uncertainty and the risk of R&D failure, government subsidies can not only directly increase the R&D expenditure of enterprises but also serve as a risk-sharing mechanism to increase the courage of enterprises to develop boldly. This study measures the strength of government support by the ratio of government subsidies to R&D investment, and the larger the ratio indicates, the stronger the government support.

7）Industry Status：The Lerner Index, also known as the Lerner Monopoly Power Index, is often used to measure a company's power in the market. The higher the Lerner Index of an individual stock, the stronger the market power and the higher the firm's position in the industry. Price movements of such firms can significantly impact supply and demand in the market as a whole. They can set higher prices in the market without worrying too much about the reaction of their competitors. Therefore, the Lerner index of individual stocks is chosen to characterize the industry position.

Specific variables are described in Table 1.

Table 1 Variable Description

Variable Dimension	Variable Name	Variable Symbols	Methods for Measuring Variables
Result Variable	High-quality development	*TFP*	LP Method
Technical Dimension（T）	Science and Technology Achievements	*STA*	The number of invention patents + the number of utility model patents + the number of design patents
	Technical Talent Support	*TTS*	$\frac{\text{Number of R\&D Personnel}}{\text{Total Number of Employees}}$

Organizational Dimension （O）	Equity Incentive	*EI*	$\frac{\text{Number of Shares Held by Management}}{\text{Total number of shares}}$
	Resource Management Ability	*RMA*	$\frac{\text{Net Profit}}{\text{Total Assets}}$
Environmental Dimensions （E）	Internal Control Quality	*ICQ*	ESG Rating on Corporate Governance
	Government Support	*GS*	$\frac{\text{Government Subsidies}}{\text{R\&D Investment}}$
Personal Condition Dimension （I）	Industry Status	*IS*	firm-level Lerner Index

3.2.3 Variable Calibration

Referring to existing studies (Fiss, 2007; Fiss, 2011), this paper adopts the direct calibration method to calibrate the raw data for outcome and antecedent conditions. Ragin (2008) suggests that calibration should be based on theoretical and substantive knowledge and incorporate data distribution. Quartile anchors are more robust for studying data based on the practical demands of sample size. This study draws on the mainstream practice adopted by academics (Fiss, 2007; Fiss, 2011; Tang & Huang, 2024) by setting the calibration anchors of 75%, 50%, and 10% for fully affiliated, intersected, and fully unaffiliated points, respectively. The variable calibration results are shown in Table 2.

Table 2 Variable Calibration Results and Descriptive Analysis

Variable Type	Variables	Fuzzy Set Calibration			Descriptive Analysis			
		Completely Affiliated	Crossover point	Completely Non-affiliated	Mean	Min	Max	Standard Deviation
Result Variable	*TFP*	8.771	8.219	6.926	8.203	6.192	10.740	0.922
Conditional Variables	*STA*	55.250	17.500	0.000	64.600	0.000	1250	175.131
	TTS	37.428	21.460	11.902	28.837	0.000	85.410	19.680
	EI	28.111	8.525	0.000	16.569	0.000	69.317	19.208
	RMA	0.146	0.089	-0.206	0.059	-0.758	0.462	0.206
	ICQ	7.205	6.825	5.861	6.728	5.000	7.920	0.633
	GS	0.021	0.012	0.003	0.020	0.419	0.000	0.042
	IS	0.238	0.170	0.021	0.166	-0.537	0.566	0.152

4 Data Analysis and Results

4.1 Necessary Condition Analysis

In this study, the NCA method and the QCA method were used for the necessary condition test. The QCA method starts from the set theory and determines the necessity of the antecedent condition by the consistency result. When the consistency is greater than 0.9, and the coverage is greater than 0.5, the condition variable can be regarded as necessary for the outcome variable (Fiss, 2007). The NCA method is based on the calculus perspective and contains two upper-bound estimation methods, namely, upper-bound regression (CR) and upper-bound envelopment analysis (CE). To ensure the robustness of the test results, this study presents all the computational results under the CR and CE methods. If the effect size (d-value) of the antecedent variable is not less than 0.1 and the Monte Carlo simulation replacement level of significance (P-value) exhibits significance, the antecedent condition can be judged as necessary (Dul, 2016; Vis & Dul, 2016).

The results of the NCA method analysis are shown in Table 3. Under the CR method, all the antecedent variables do not satisfy the characteristics that the effect size is not less than 0.1, and the Monte Carlo simulation replacement level of significance exhibits significance. Under the CE method, the effect size of resource management capability is greater than 0.1, and the Monte Carlo simulation replacement level of significance is significant. Considering that the variable "resource management capability" in this study is a continuous variable, the CR method is more applicable. Therefore, it was determined that all antecedent variables were not necessary for the outcome variable. Table 4 further reports the results of analyzing the bottleneck level of necessity for each antecedent variable. The results show that 9% of resource management capability, 0.3% of internal control quality, and 0.5% of industry position are required to achieve 60% of firms' total factor productivity.

Table 3 Analysis of the Necessity of Various Precedent Conditions by the NCA Method

Condition	Method	Accuracy	Ceiling Zone	Scope	d value	P value
STA	CR	100%	0.000	0.94	0.000	1.000
	CE	100%	0.000	0.94	0.000	1.000
TTS	CR	100%	0.000	0.99	0.000	0.701
	CE	100%	0.000	0.99	0.000	0.701
EI	CR	100%	0.000	0.94	0.000	1.000
	CE	100%	0.000	0.94	0.000	1.000
RMA	CR	97.3%	0.079	0.99	0.080	0.000
	CE	100%	0.104	0.99	0.105	0.000
ICQ	CR	95.5%	0.018	0.99	0.018	0.033
	CE	100%	0.007	0.99	0.007	0.217
GS	CR	99.1%	0.004	0.98	0.004	0.471
	CE	100%	0.006	0.98	0.006	0.501
IS	CR	100%	0.009	0.99	0.009	0.019
	CE	100%	0.018	0.99	0.018	0.005

Note: a. Use the calibrated fuzzy set membership degree values. d. A value of $0 \leq d < 0.1$ indicates a low level; $0.1 \leq d < 0.3$ indicates a medium level; 0.3≤d＜0.5 indicates a medium-high level; d≥0.5 indicates a high level. The number of permutation tests in NCA analysis is 10,000 times.

Table 4 Analysis of the Necessity and Bottleneck Levels (%) of Various Precedent Conditions by NCA Method

TFP	STA	TTS	EI	RMA	ICQ	GS	IS
0	NN	NN	NN	NN	NN	NN	NN
10	NN	NN	NN	NN	NN	NN	NN
20	NN	NN	NN	NN	NN	NN	NN
30	NN	NN	NN	NN	NN	NN	NN
40	NN	NN	NN	0.4	NN	NN	NN
50	NN	NN	NN	4.7	NN	NN	NN
60	NN	NN	NN	9.0	0.3	NN	0.5
70	NN	NN	NN	13.3	NN	1.4	1.4
80	NN	NN	NN	17.6	NN	4.4	2.2
90	NN	NN	NN	21.9	NN	7.3	3.1
100	NN	3.0	NN	26.2	1.8	10.2	4.0

Note: "NN" indicates that the antecedent variable is not necessary for the outcome variable.

The results of the analysis of the QCA method are shown in Table 5. The results show that the level of agreement for all the antecedent variables is less than 0.9, which does not constitute a necessary condition for the outcome variable. This result also further provides proof of NCA's previous analytical results. Since there is no necessary condition for electronic communication enterprises to achieve high-quality development, it is necessary to investigate further the impact of the joint effect of the antecedent variables on the enhancement of total factor productivity.

Table 5 Necessity Analysis of the QCA Method for Various Antecedent Conditions

Conditional Variables	High-quality development		~High-quality development	
	Consistency	Degree of coverage	Consistency	Degree of coverage
STA	0.595	0.662	0.507	0.451
~STA	0.506	0.562	0.620	0.550
TTS	0.561	0.611	0.626	0.545
~TTS	0.582	0.661	0.552	0.502
EI	0.473	0.534	0.630	0.569
~EI	0.618	0.676	0.483	0.423
RMA	0.706	0.674	0.635	0.484
~RMA	0.460	0.611	0.573	0.609
ICQ	0.630	0.650	0.576	0.475
~ICQ	0.491	0.591	0.575	0.555
GS	0.516	0.555	0.677	0.583
~GS	0.612	0.703	0.483	0.444
IS	0.627	0.647	0.611	0.504
~IS	0.520	0.626	0.572	0.551

Note: "~" represents "not".

4.2 Analysis of Configuration Results

4.2.1 Configuration Result

Referring to the mainstream practice of existing studies (Tan et al., 2019; Xue et al., 2024; Fiss, 2007; Fiss, 2011), the number of cases cutoff was set to 1, the consistency threshold was set to 0.8, and the PRI consistency threshold was set to 0.7. In the counterfactual analyses, the “present or absent” condition was set for each variable.The truth table is shown in Appendix I.

The intermediate solution was analyzed with simple counterfactuals compared to the complex solution, and the simple solution was the result after the complex counterfactual analysis was performed. This study judges the core conditions based on the intermediate solution and the simple solution to ensure that the configuration results are more realistic. The grouping path results are shown in Table 6, and the grouping analysis results are shown in Table 7.

Table 6 Conditional Configuration Paths Result

	No.	Path of Solutions	Raw Coverage	Unique Coverage	Consistency
Parsimonious Solution	1	~EI*RMA*ICQ	0.282	0.027	0.871
	2	TTS*~EI*~RMA*GS*~ICQ	0.123	0.024	0.904
	3	IS*STA*TTS*EI*~GS	0.129	0.009	0.843
	4	STA*TTS*EI*RMA*~GS	0.128	0.0007	0.871
	5	TTS*EI*RMA*GS*~ICQ	0.140	0.049	0.878
	6	STA*~TTS*~GS*ICQ	0.222	0.030	0.948
Intermediate Solution	1	STA*TTS*EI*RMA*~GS*ICQ	0.110	0.002	0.872
	2	IS*STA*TTS*EI*RMA*~GS	0.119	0.007	0.863
	3	IS*STA*TTS*EI*~GS*ICQ	0.111	0.009	0.840
	4	~STA*TTS*~EI*~RMA*GS*~ICQ	0.076	0.010	0.871
	5	~IS*TTS*~EI*~RMA*GS*~ICQ	0.107	0.017	0.925
	6	IS*TTS*EI*RMA*GS*~ICQ	0.137	0.048	0.891
	7	IS*STA*~EI*RMA*GS*ICQ	0.117	0.013	0.921
	8	~IS*~TTS*~EI*RMA*~GS*ICQ	0.122	0.006	0.975
	9	IS*STA*EI*RMA*~GS*ICQ	0.125	0.011	0.886
	10	~IS*STA*~TTS*~RMA*~GS*ICQ	0.141	0.011	0.971

Table 7 High-quality development Configuration Results

Conditional Variables	"technology-resource" co-driven type		"technology-led" type	"talent-government" support type			"resource-governance" synergy type		"technology-governance" linkage type	
	S_{1a}	S_{1b}	S_{2}	S_{3a}	S_{3b}	S_{3c}	S_{4a}	S_{4b}	S_{5a}	S_{5b}
IS		•	●		⊗	•	•	⊗	•	⊗
STA	●	●	●	⊗			•		●	●
TTS	●	●	●	●	●	●		⊗	⊗	⨂
EI	●	●	●	⨂	⨂	●	⨂	⨂	•	
RMA	●	●		⨂	⨂	●	●	●	•	⊗
ICQ	•		•	⨂	⨂	⨂	●	●	●	●
GS	⨂	⨂	⨂	●	●	●	•	⊗	⨂	⨂
Consistency	0.872	0.863	0.840	0.871	0.925	0.891	0.921	0.975	0.886	0.971
Raw coverage	0.110	0.119	0.111	0.076	0.107	0.137	0.117	0.122	0.125	0.141
Unique coverage	0.002	0.007	0.009	0.010	0.017	0.048	0.013	0.006	0.011	0.011
Solution consistency	0.856									
Solution coverage	0.594									

Note: ● indicates the presence of a core condition; • indicates the presence of a peripheral condition; ⨂ indicates the absence of a core condition; ⊗ indicates the absence of a peripheral condition; "blank" signifies that a condition may or may not be present.

4.2.2 Configuration Analysis

After the condition variables were combined in a linked fashion, 10 major grouping paths were finally formed. The overall solution's coverage is 0.594, and its consistency level is 0.856, which exceeds the initial threshold. The grouping results have strong explanatory power. Based on the existing characteristics of the core conditions, the grouping paths are named "technology-resource" co-driven type, The "technology-led" type, "talent-government" support type, "resource-governance" synergy type and "technology-governance" linkage type.

(1) "technology-resource" co-driven type（S_{1a} S_{1b}）——The development of Resource Orchestration Theory

The S_1 grouping contains two paths, S1a and S1b, with the common core conditions of high-tech achievements, high-tech talent support, high equity incentives, and high resource management capability. This means that enterprises with weak government support but strong resource management capability and high output of scientific and technological achievements can realize high-quality development by strengthening the cultivation of scientific and technological talents and implementing effective equity incentives. This path is more evident in enterprises with high industry status.

This pattern further proves the conduction mechanism of "resource combination (technical achievement + talent support) → capability construction (resource management) → value creation." It reflects the endogenously driven compensation mechanism and the dynamic capability-building path. Firstly, the synergistic effect of technological achievements and resource management makes up for the lack of external support. When the government's support is insufficient, scientific and technological achievements and technical talents, as the internal resources of the enterprise, form strategic complementarity. The reserve of scientific and technological achievements builds technical barriers for the enterprise. Strong resource management capability can accelerate the penetration of advanced technology. This further verifies the factor substitution effect in the innovation ecosystem theory, i.e., internal capability can compensate for the lack of external support. Secondly, based on the human capital theory, the enterprise's scientific and technological talents are not only the enterprise's human capital but also intellectual capital. Effective equity incentives for technology-intensive electronic communication enterprises will promote the transformation of tacit knowledge. Finally, the synergistic effect of scientific and technological achievements, talent reserve, and resource management promotes the construction of enterprise dynamic ability. The optimization of technology and the talent reserve provide absorptive capacity, and the resource management capacity provides integration and restructuring capacity.

A typical example of this configuration is China's Shengbang Co. As a leading comprehensive analog IC company in China, it has always adhered to the principle of independent product development and shaped its core professional team. The company adopts the "asset-light + R&D" model to strengthen its ability to absorb, integrate and utilize resources. Through the double helix upgrading of technology association and resource learning, the company has built an endogenous growth engine that does not rely on external policy support and has achieved high-quality development.

(2) "technology-led" type（S_2）——Validation of the technology lock-in effect

The core conditions of the S_2 grouping are high industry status, high-tech achievements, high-tech talent support, and high equity incentives. It shows that for enterprises with high industry status and exemplary scientific and technological achievements, continuous improvement of technological strength is the main way to realize high-quality development.

This grouping verifies the mechanism of creative destruction and the theory of technological path dependence. It reveals the new value-added path of technological capital in the era of the digital economy. In the electronic communication industry, enterprises with high industry status can use the economy of scale effect to form a positive feedback loop between the advantages of market power and technological strength and give full play to the cyclic effect of the “accumulation-release” of technological potential energy. Scientific and technological achievements and talent reserves build technological advantages. The advantage of the industry status will transform the technological advantage into the standard-setting right and technology diffusion barriers, which will accelerate the transformation of technological potential energy into economic value. At the same time, management is the core pillar of the enterprise, and an effective equity incentive mechanism helps to transform the core talent into “quasi-owners” to realize the maximization of the value of human capital.

A typical example of this configuration is Aiwei Electronics in China. The enterprise insists on implementing the mechanism of accumulating technological potential, forming a pool of technological reserves with high-intensity R&D investment and scientific and technological achievement output, and constructing technological barriers in niche fields. At the same time, the enterprise actively introduces domestic and foreign high-end technical talents, with the proportion of R&D personnel reaching 64.59% and the proportion of management shareholding reaching 64.16%, both of which far exceed the average level of the sample.

(3) "talent-government" support type（S_{3a} S_{3b} S_{3c}）——Refinement of the Innovation Ecosystem Theory

In the S_3 grouping, the common core conditions are high technological talent support and high government support. The S3c path shows that when high industry status exists as a secondary condition, high equity incentives, and high resource management capability are also core conditions. This suggests that for firms with low industry status and poor internal control quality, strong government support and cultivation of technological talent can compensate for the lack of resource management capability. For enterprises with high industry status but poor internal control quality, in addition to the support of the government and talents, it is also necessary to implement effective equity incentives and improve resource management ability.

This configuration reflects the compensation mechanism for resource gaps. The governance effect of “incentive-constraint-rebalancing” is achieved through risk hedging. On the one hand, enterprises with low industry status face double resource constraints. The external market bargaining power is weak, lacks scale effect, and insufficient internal resource management ability is insufficient. At this time, strong government support can directly fill the financial resource gap and reduce the trial-and-error cost of R&D and innovation. At the same time, the cultivation of scientific and technological talents can help enterprises break through the bottleneck of technological resources through the accumulation of intellectual capital. The synergistic effect of the two stimulates leveraged innovation, realizing technological catch-up and productivity improvement. On the other hand, although enterprises with high industry status have a certain degree of market dominance, deficiencies in the quality of internal control may bring about hidden dangers such as waste of resources and inefficient transformation of technological achievements.

The synergistic effect of government support and talent pool forms a risk-hedging mechanism. Governance shortcomings are compensated through capital buffers and invisible knowledge assets. At the same time, the equity incentive mechanism plays the dual role of positive incentives and implicit constraints. It inhibits short-term behavior through interest bundling, forcing management to improve resource management ability through equity dilution to minimize agency costs.

A typical example of this configuration is Allwinner Technology Co. The company is an outstanding high-performance analog device and wireless interconnect chip designer in China. The company insists on cultivating compound talents and has established a scientific, standardized, and systematic human resources training system. During its development period, the government subsidized its R&D strongly, accelerating the transformation of its technological achievements through targeted support for AIoT chip R&D, among others.

(4) "resource-governance" synergy type（S_{4a} S_{4b}）——The dampening effect of internal governance on agency costs

The common core conditions in the two groupings of category S_4 are high resource management capability, high internal control quality, and low equity incentives. In S_{4a}, high industry status, high technology achievements, and high government support are the auxiliary conditions. In S_{4b}, low industry status, low scientific and technological talent support, and low government support are the auxiliary conditions. Regardless of industry position, the ability to manage resources to maintain a high level of internal control quality is the main way to achieve high-quality growth when equity incentives are not at a high level.

This grouping reflects the endogenous driving logic of resource management and the inhibiting effect of internal governance on agency costs. First, for the enterprise as a whole, refined resource management helps the enterprise to realize the deployment and integration of old and new resources, thus promoting the transformation of technological innovation results. This will form a compensation mechanism of "efficiency instead of incentives" when equity incentives are insufficient and compensate for the lack of direct incentives for management. Secondly, reasonable internal control ensures the upgrading of resource utilization from static to dynamic through the transparency of decision-making, process standardization, and supervision normalization. Due to the technology-intensive characteristics of electronic communication enterprises, the iterative upgrading of technology is highly required. Enterprises with high-quality internal control can quickly adjust the resource allocation structure according to market changes and compensate for the delay in strategic response caused by insufficient equity incentives. Third, rigid governance and flexible resource management form a closed-loop value-added "hard governance and soft resources" system. Without the "risk-sharing" mechanism of equity incentives, strong internal control and efficient management of resources can also be controlled through risk quantification.

A typical example of this configuration is the Chinese company SangYi Technology Co. The company is a global core supplier of electronic circuit substrates. Against weak government subsidies, the company has built a dual engine of "lean operation + compliance and innovation" in copper-clad laminates using refined asset allocation and a strict internal control system. The deep synergy between resources and governance breaks through the traditional incentives and environmental constraints, verifying the core logic of "governance empowers resource efficiency."

(5) "technology-governance" linkage type（S_{5a} S_{5b}）——Innovation paradigm of symbiotic

evolution between "Technology-Institution"

The common core conditions in the S_5 grouping are high-tech achievements, high internal control quality, and low government support. The S_{5a} grouping path shows high industry status, high equity incentives, high resource management ability, and low scientific and technological talent support as the auxiliary conditions. The S_{5b} grouping path shows low industry status and low resource management ability as the auxiliary conditions. It shows that in the case of low government support, enterprises with low industry status but with perfect corporate governance systems should focus on developing internal technology and realizing technological breakthroughs. Firms with high industry status and high resource management capability should maintain high-quality internal control and scientific and technological output to enhance their competitive advantage.

This grouping reveals the trend of two-way integration of "technology governance" and "governance technology" in the era of the digital economy. The lack of government support means enterprises have limited access to external resources. Enterprises should focus on constructing endogenous capacity, emphasizing the endogenization of innovation under resource constraints. Strict internal control guarantees the accumulation and transformation of scientific and technological achievements, and the pool of technological assets formed by scientific and technological achievements further promotes the improvement of internal governance. On the one hand, for enterprises with high industry status, equity incentives, and resource management play the function of catalysts, accelerating the penetration of technology into all production processes. On the other hand, enterprises with low industry status face the dual difficulties of limited external resources and a weak talent base. Strictly controlling the level of internal governance, screening highly feasible technology direction at the initial stage, reducing the waste of R&D resources in the middle stage through process control, and accelerating technology commercialization later to achieve technological breakthroughs.

A typical example of this configuration is the Chinese company Gore AG. The company is a globally organized technology innovation enterprise. Under the low market situation, the company makes full use of the rigidity of governance and the flexibility of technology to promote the deep integration of the two and become a "gas pedal" of technological innovation. The company strictly controls the standardization of production processes and efficiently penetrates technology into all production processes, thus achieving a quantitative to qualitative leap in productivity.

4.3 Robustness Test

The three primary methods of robustness testing include fine-tuning the calibrated anchor points, changing the case frequency cutoffs, and fine-tuning the consistency thresholds. This study's consistency threshold was 0.8 to 0.9, and PRI was 0.7 to 0.75. after performing the histogram analysis again, the results of the formed histogram analysis did not change substantially, which indicates that the study results have a high level of robustness. The results of the robustness test are presented in Appendix II.

5 Conclusion and Contribution

5.1 Conclusion

Based on the TOEI framework, this paper adopts the fsQCA method to explore the multiple grouping paths of electronic communication enterprises to realize high-quality development. The study draws the following conclusions:

First, industry status, scientific and technological achievements, scientific and technological talent support, equity incentives, resource management ability, internal control quality, and government support are not necessary for realizing high-quality development. This indicates that the independent role of individual factors cannot accomplish the leap of development quality—high-quality development results from the synergistic effect of group matching antecedent conditions.

Secondly, for electronic communication enterprises, the strategies for realizing high-quality development can be summarized into five types. (1) "Technology-resource" co-driven type. Enterprises with strong resource management capabilities and high output of scientific and technological achievements can strengthen the cultivation of scientific and technological talents and strengthen the equity incentive mechanism to achieve high-quality development. (2) "Technology-led" type. For enterprises with high industry status and exemplary scientific and technological achievements, continuous improvement of technological strength is the main way to maintain competitive advantage. (3) "Talent-government" support type. For enterprises with low industry status and poor internal control quality, strong government support and scientific and technological talent cultivation can compensate for the lack of resource management capability. For enterprises with high industry status but poor internal control quality, in addition to the government's and talents' support, it is also necessary to implement an effective equity incentive mechanism and improve resource management capabilities. (4) "Resource-governance" synergy. Regardless of industry status, maintaining a high level of internal control quality and resource management capability is the core of high-quality development when equity incentives are not high. (5) "Technology-Governance" linkage. Under low government support, enterprises with low industry status but perfect corporate governance systems should focus on developing internal technology and realizing technological breakthroughs. Enterprises with high industry status and strong resource management capabilities should maintain high-quality internal control and scientific and technological output to enhance their competitive advantages.

5.2 Contribution

The theoretical contribution of this study lies in the following three points: First, the study supports the predictions of the TOE theoretical framework. It validates the possibility of factor substitution under different dimensions. We extend the TOE framework on top of the TOE theoretical framework to comprehensively capture the linkages between the influencing factors at the technological, organizational, and environmental levels and the firm's conditions. This further extends the explanatory scope and application scenarios of the TOE framework. Second, the study findings further develop the resource orchestration theory and refine the scenario-based application of the dynamic capabilities of innovation theory. The study further empirically demonstrates the conduction mechanism of resource orchestration, capability construction, and value creation. Third, the study reveals the multiple equivalent paths and underlying logic for electronic communication enterprises to realize high-quality development, breaking through the paradigm of traditional linear analysis. The practical contribution lies in the study revealing a new path for enterprises to build compound competitive advantages through factor synergy in the digital economy era. It provides a "capability-situation" adaptation guide for the strategic formulation of high-quality development of telecommunication enterprises in various countries.

References:

[1] Balk, B.M. (2015). Measuring and relating aggregate and subaggregate total factor productivity change without neoclassical assumptions. *Statistica Neerlandica*, 69, 21 - 48. https://doi.org/10.1111/stan.12045

[2] Balk, B.M. (2020). A novel decomposition of aggregate total factor productivity change. *J Prod Anal*, 53, 95 – 105. https://doi.org/10.1007/s11123-019-00548-7

[3] Barney, J. B. . (1991). Firm resource and sustained competitive advantage. *Journal of Management*, 17(1), 99-120.https://doi.org/10.1177/014920639101700108

[4] Cai, L. , & Luo, H. . (2021). Can executive equity incentives promote high-quality development of enterprises? —— mediating effect based on innovation. *E3SWC*.https://doi.org/10.1051/e3sconf/202129202008

[5] Cheng, X.G. & Song, C.. (2023). Futures Investment, Financing Constraints and Enterprise Total Factor Productivity.*Jiang-huai Tribune*(05),39-48.https://doi.org/10.16064/j.cnki.cn34-1003/g0.2023.05.011.

[6] Di, C.Z. & Xue, Y.Z.. (2024). R&D Alliance, Open Innovation and Enterprise Total Factor Productivity Growth.*Journal of Quantitative & Technological Economics*(12),111-132.https://doi.org/10.13653/j.cnki.jqte.20240926.005.

[7] Dul, J. (2016). Identifying single necessary conditions with NCA and fsQCA. *Journal of Business Research*, 69, 1516-1523.https://doi.org/10.1016/j.jbusres.2015.10.134

[8] Fan, H. , Yin, J. , Usman, M. , & Li, Z. . (2024). Intellectual property protection and total factor productivity of enterprises: a quasi-natural experiment of intellectual property courts. *Finance Research Letters*, 70.https://doi.org/10.1016/j.frl.2024.106236

[9] Fang, X.M. & Hu, D.. (2023). Corporate ESG Performance and Innovation:Empirical Evidence from A-share Listed Companies.*Economic Research Journal*(02),91-106.https://d.wanfangdata.com.cn/periodical/jjyj202302007

[10] Fiss, P. C. . (2007). A set-theoretic approach to organizational configurations. *The Academy of Management Review*, 32(4), 1180-1198.https://doi.org/10.5465/AMR.2007.26586092

[11] Fiss, P. C. . (2011). Building Better Causal Theories: A Fuzzy Set Approach to Typologies in Organization Research. *Academy of Management Journal*, 54(2), 393-420.https://doi.org/10.5465/amj.2011.60263120

[12] Fu, J.L. & Huang, X.H.. (2023). How Does ESG Performance Affect the Total Factor Productivity of Enterprises?.*Economic Survey*(03),108-117.https://doi.org/10.15931/j.cnki.1006-1096.2023.03.010.

[13] Harris, R. & Li, S.Y. (2019). Government assistance and total factor productivity: Firm-level evidence from China. *Journal of Productivity Analysis*, 52, 1-27.https://doi.org/10.1007/s11123-019-00559-4

[14] Harris, R.D., & Moffat, J. (2020). The Impact of Product Subsidies on Plant‐Level Total Factor Productivity in Britain, 1997–2014. *Political Economy: Taxation*. https://doi.org/10.1111/sjpe.12240

[15] Ji, X.X. & Huang, M.. (2022). Digital Level and Enterprise Value: An Empirical Study from the Perspective of Resource Orchestration.*Modern Economic Research*(04),105-113.https://doi.org/10.3969/j.issn.1009-2382.2022.04.011

[16] Lajos Baráth, Fert, I. , & Bojnec, T. . (2020). The effect of investment, lfa and agri〆nvironmental subsidies on the components of total factor productivity: the case of slovenian farms. *Journal of Agricultural Economics*.https://doi.org/10.1111/1477-9552.12374

[17] Levinsohn, J., & Petrin, A. (2003). Estimating production functions using inputs to control for unobservables. *Review of Economic Studies*, 70(2), 317-341. https://doi.org/10.1111/1467-937X.00246

[18] Lu, X.D. & Lian, Y.J.. (2012). Estimation of Total Factor Productivity of Industrial Enterprises in China: 1999—2007.*China Economic Quarterly*(02),541-558.https://doi.org/10.13821/j.cnki.ceq.2012.02.013.

[19] Olley, G. S. , & Pakes, A. (1996). The dynamics of productivity in the telecommunications equipment industry. *Social Science Electronic Publishing*.https://doi.org/10.3386/W3977

[20] Pei, X. & Zhang, M.Z.. (2024). Research on the Improvement Paths of Total Factor Productivity for the Specialized and Sophisticated Enterprises Under the Perspective of Configuration.*Science and Technology Management Research*, 44(17), 10-17.https://doi.org/10.3969/j.issn.1000-7695.2024.17.002

[21] Penrose, E. . (1995). The theory of the growth of the firm. *Long Range Planning*, 29(4), 1.https://doi.org/10.1016/S0024-6301(96)90295-2

[22] Porter, M.E., & Heppelmann, J.E. (2014). How Smart, Connected Products Are Transforming Competition. *Harvard Business Review*, 92, 18.

[23] Rapuluchukwu Peter Igbojioyibo.(2024).The Impact of Internal Control Systems on Asset Protection and Financial Reporting Accuracy in SMEs.*Asian Journal of Economics, Business and Accounting*(12),65-80.https://doi.org/10.9734/AJEBA/2024/V24I121592

[24] Solow, R.M. (1957) Technical Change and the Aggregate Production Function. Review of Economics and Statistics. *The Review of Economics and Statistics*, 39, 312-320.https://doi.org/10.2307/1926047

[25] Tan, H.B., Fan, Z.T. & Du, Y.Z.. (2019). Technology Management Capability, Attention Distribution and Local Government Website Construction:A Configurational Analysis Based on the TOE Framework.*Journal of Management World*(09),81-94.https://doi.org/10.19744/j.cnki.11-1235/f.2019.0119.

[26] Tornatzky, L. G. , Fleischer, M. , & Chakrabarti, A. K. . (1990). processes of technological innovation. *Lexington Books*. https://www.researchgate.net/publication/291824703_Technological_Innovation_as_a_Process

[27] Ullah, F., Qayyum, S., Thaheem, M.J., Al-turjman, F.M., & Sepasgozar, S.M. (2021). Risk management in sustainable smart cities governance: A TOE framework. *Technological Forecasting and Social Change*, 167, 120743.https://doi.org/10.1016/J.TECHFORE.2021.120743

[28] Vis, B., & Dul, J. (2018). Analyzing Relationships of Necessity Not Just in Kind But Also in Degree: Complementing fsQCA With NCA. *Sociological methods & research*, 47(4),

872 – 899. https://doi.org/10.1177/0049124115626179

[29] Wang, S.X. & Wang, Z.M.. (2023). Corporate ESG Performance,Innovation and Total Factor Productivity.*Macroeconomics*(11),62-74.https://doi.org/10.16304/j.cnki.11-3952/f.2023.11.009.

[30] Wang, X.. (2024). Research on the transformation configuration of S&T achievements in high-tech industries under the TOE framework.Science *Research Management*(06),164-173.https://doi.org/10.19571/j.cnki.1000-2995.2024.06.017.

[31] Xu, Y.H. & Li, W.C.. (2024). Research on the Mobilization Mechanism of Primary-Level Governance in Digital Society: From TOE to TOEI.*Jilin University Journal Social Sciences Edition*(04),219-234+240.https://doi.org/10.15939/j.jujsse.2024.04.sh2.

[32] Xue, Y.X., Zhang, J.C., Zhang, Y.& Yu, X.Y.. (2024). Research on the linkage path of high-quality development of Chinese manufacturing enterprises.*Science Research Management*(07),29-39.https://doi.org/10.19571/j.cnki.1000-2995.2024.07.004.

[33] Zhang, S.F. & Chen, Y.Q.. (2024). Study on the improvement path of innovation performance of "SRDI" small and medium-sized enterprises.*Studies in Science of Science*, 42(4), 873-884.https://doi.org/10.16192/j.cnki.1003-2053.20230419.001

[34] Zhang, S.S. & Chen, K.X.. (2024). Corporate ESG Performance and Digital Technology Innovation.*Collected Essays on Finance and Economics*(09),69-79.https://doi.org/10.13762/j.cnki.cjlc.20240709.002.

[35] Zeng, J.W., Li, B.Z., Song, P. & Wang, X.. (2023). The Driving Path of Enterprise Original Innovation:A Configuration Analysis Based on TOE Framework.*Science & Technology Progress and Policy*(01),71-80.

[36] Zheng, L. , Ulrich, K. , & Javier Sendra-García. (2021). Qualitative comparative analysis: configurational paths to innovation performance. *Journal of Business Research*, 128(3), 83-93.https://doi.org/10.1016/j.jbusres.2021.01.044

[37] Zhou, M.H., Lin, B. & Lin, D.J.. (2016). Management Power,Internal Control and Corruption Governance.*Accounting Research*(03),56-63+96.https://doi.org/10.3969/j.issn.1003-2886.2016.03.008

[38] Zhou, W.H., Li, M.Y. & Li, Y.N.. (2024). Digital Transformation, Total Factor Productivity and Enterprise Value Creation.*Statistics & Decision*(16),178-182.https://doi.org/10.13546/j.cnki.tjyjc.2024.16.032.

Appendix I Truth Table

Table 1 Truth Table

IS	STA	TTS	EI	RMA	GS	ICQ	number	TFP	raw consist.	PRI consist.	SYM consist
0	1	0	0	1	0	1	1	1	0.974271	0.951456	0.951456
0	1	0	0	0	0	1	4	1	0.967742	0.940541	0.940541
0	0	0	0	1	0	1	1	1	0.963415	0.92683	0.926829
0	0	0	0	1	0	0	2	1	0.949782	0.907631	0.907631
0	1	0	1	0	0	1	2	1	0.95499	0.893023	0.901409
1	1	0	0	1	0	0	1	1	0.941176	0.855895	0.855895
0	0	1	0	0	0	0	1	1	0.927778	0.840491	0.840491
1	1	1	0	1	1	1	1	1	0.927184	0.83871	0.83871
1	1	0	0	1	1	1	1	1	0.926956	0.821276	0.821277
1	1	0	1	1	0	1	1	1	0.92126	0.811321	0.811321
0	1	1	0	0	1	0	2	1	0.939177	0.805714	0.810345
0	0	0	0	1	1	0	1	1	0.903704	0.783334	0.783333
0	1	0	0	0	0	0	2	1	0.915009	0.780374	0.780374
1	0	0	0	1	1	1	1	1	0.898936	0.77647	0.776471
1	1	1	1	0	0	1	1	1	0.889813	0.770562	0.770563
1	0	1	0	1	0	0	1	1	0.879371	0.755319	0.755319
0	0	1	0	0	1	0	1	1	0.897561	0.743903	0.743902
0	0	1	0	0	0	1	4	1	0.829047	0.743182	0.743182
1	1	1	1	1	1	0	2	1	0.872774	0.72973	0.72973
1	1	1	1	1	0	0	1	1	0.879496	0.727642	0.727642
1	1	1	1	1	0	1	2	1	0.862937	0.726257	0.726257
0	1	1	1	1	0	1	1	1	0.884937	0.724999	0.725
1	0	1	0	0	1	0	1	1	0.894169	0.718391	0.744048
1	0	0	0	1	0	0	3	1	0.82764	0.716837	0.716837
1	0	0	0	1	0	1	1	1	0.870544	0.714876	0.73617
1	0	1	0	1	0	1	3	1	0.844776	0.711911	0.711911
1	0	1	1	1	1	0	1	0	0.876645	0.698795	0.698795
0	0	0	1	0	0	1	2	0	0.895062	0.698225	0.842857
1	0	1	0	0	1	1	2	0	0.842672	0.689362	0.689362
0	1	1	0	1	1	0	1	0	0.897331	0.6875	0.718954
0	1	1	1	0	0	1	1	0	0.857442	0.674641	0.674641
1	1	0	1	1	0	0	1	0	0.837313	0.671687	0.671687
1	1	1	1	1	1	1	3	0	0.819415	0.664078	0.664078
0	1	0	1	1	0	0	3	0	0.83574	0.659176	0.659176
1	1	1	1	0	1	1	2	0	0.834116	0.645485	0.645485
1	1	0	0	1	1	0	1	0	0.851968	0.620968	0.620968
0	1	1	0	0	0	0	1	0	0.85396	0.611842	0.611842
0	1	0	1	0	1	1	1	0	0.839506	0.578378	0.578378

1	0	0	0	0	1	0	1	0	0.822454	0.572327	0.572327
1	1	1	0	1	0	0	1	0	0.839323	0.563218	0.563218
1	0	1	1	1	1	1	1	0	0.811867	0.557823	0.557823
1	1	0	1	1	1	0	1	0	0.789238	0.553798	0.553798
1	0	1	0	1	1	0	5	0	0.744508	0.550812	0.551935
0	0	0	0	0	1	1	3	0	0.758748	0.549828	0.549828
0	0	0	1	0	1	1	1	0	0.816017	0.532967	0.532967
1	1	1	1	0	1	0	1	0	0.816602	0.520202	0.520202
0	1	1	0	0	1	1	3	0	0.77795	0.515254	0.515254
1	1	0	1	1	1	1	2	0	0.785915	0.509678	0.509678
0	0	0	1	1	0	0	1	0	0.859281	0.5	0.5
1	0	1	1	1	0	0	1	0	0.826923	0.491525	0.491525
0	1	0	0	0	1	0	1	0	0.86201	0.487342	0.513334
0	1	1	1	0	1	1	1	0	0.724595	0.415625	0.452381
0	0	1	1	0	1	1	2	0	0.689256	0.4125	0.4125
1	0	0	1	1	0	0	3	0	0.734899	0.392307	0.392307
1	0	0	1	1	1	1	1	0	0.819095	0.386364	0.386364
0	1	1	1	0	1	0	2	0	0.686241	0.334519	0.334519
1	0	1	1	0	0	0	1	0	0.719346	0.304054	0.304054
0	0	1	1	0	0	0	1	0	0.712329	0.3	0.3
0	1	0	1	0	1	0	3	0	0.679417	0.281632	0.281632
0	0	0	1	0	1	0	2	0	0.729729	0.281045	0.281045
1	0	0	1	1	0	1	4	0	0.718147	0.274834	0.320463
0	0	1	1	0	1	0	2	0	0.585412	0.178707	0.178707

Appendix II Robustness Test Results

Table 1 Conditional Configuration Paths Result

	No.	Path of Solutions	Raw Coverage	Unique Coverage	Consistency
Parsimonious Solution	1	STA*~TTS*~GS*ICQ	0.222	0.030	0.948
	2	~EI*RMA*GS*ICQ	0.178	0.019	0.885
	3	TTS*~EI*~RMA*GS*~ICQ	0.123	0.021	0.904
	4	STA*TTS*EI*RMA*~ICQ	0.131	0.030	0.879
	5	IS*STA*TTS*EI*~GS	0.129	0.009	0.843
	6	STA*TTS*EI*RMA*~GS	0.128	0.0005	0.871
Intermediate Solution	1	STA*TTS*EI*RMA*~GS*ICQ	0.110	0.002	0.872
	2	IS*STA*TTS*EI*~GS*ICQ	0.111	0.009	0.840

3	~STA*TTS*~EI*~RMA*GS*~ICQ	0.076	0.010	0.871
4	~IS*TTS*~EI*~RMA*GS*~ICQ	0.107	0.017	0.925
5	IS*STA*TTS*EI*RMA*~ICQ	0.127	0.041	0.886
6	IS*STA*~EI*RMA*GS*ICQ	0.117	0.022	0.921
7	IS*STA*EI*RMA*~GS*ICQ	0.125	0.011	0.886
8	~IS*STA*~TTS*~RMA*~GS*ICQ	0.141	0.011	0.971

Table 2 Conditional Configuration Analysis

Configuration	Solution							
	S_1	S_2	S_{3a}	S_{3b}	S_{3c}	S_4	S_{5a}	S_{5b}
IS		●		⊗	•	•	•	⊗
STA	●	●	⊗		●	•	●	●
TTS	●	●	●	●	●		⊗	⨂
EI	●	●	⨂	⨂	●	⨂	•	
RMA	●	●	⨂	⨂	●	●	•	⊗
ICQ	•	•	⊗	⊗	⨂	•	●	●
GS	⨂	⨂	●	●		●	⨂	⨂
Consistency	0.872	0.84	0.871	0.925	0.886	0.921	0.886	0.971
Raw coverage	0.11	0.111	0.076	0.107	0.127	0.117	0.125	0.141
Unique coverage	0.002	0.009	0.01	0.017	0.041	0.022	0.011	0.011
Solution consistency	0.881							
Solution coverage	0.515							

Note: ● indicates the presence of a core condition; • indicates the presence of a peripheral condition; ⨂ indicates the absence of a core condition; ⊗ indicates the absence of a peripheral condition; "blank" signifies that a condition may or may not be present.