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Collaborative governance in action: driving ecological sustainability in the Yangtze River basin

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Implementing a collaborative governance framework across administrative boundaries is crucial for preserving the Basin's ecological integrity and mitigating institutional fragmentation. Based on 19 cases of inter-provincial collaborative governance of ecological environment in the Yangtze River Basin of China, this study uses the fuzzy set qualitative comparative analysis method to explore the influencing factors and complex causal mechanism of the effect of inter-provincial collaborative governance. The results show that technology empowers relationship driving, institutions reinforce interactive driving, and internal and external interaction driving modes promote collaborative governance. Perceived factors are essential in motivating provinces to participate in collaborative governance. External factors play a hygienic role in collaborative governance, and internal factors play a motivated role. The roles of the two types of factors are separate but complementary. In view of this, government should attention to regional environmental concerns, ensuring consistent alignment of internal and external factors and fostering synergies to improve governance effectiveness.

KEYWORDS

watershed ecological environment, inter-provincial collaborative governance, driving paths, fuzzy set qualitative comparative analysis, environmental policy and governance

1 Introduction

The Yangtze River basin is China's strategic hub and water source, supporting economic development and contributing significantly to its long cultural history. It covers 11 provinces and cities along the Yangtze River and spans three plates in eastern, central and western China. It is a typical transboundary river. In the long term, promoting the high-quality development of the Yangtze River Economic Belt fundamentally relies on the establishment of a high-quality ecological environment within the Yangtze River Basin. Currently, its ecological environment faces many problems. Firstly, the industrial emissions, agricultural non-point source pollution, and urban domestic waste pollution in the Yangtze River Basin are widespread and pose significant challenges for control (Chun, 2019). Secondly, biodiversity protection is still facing severe challenges, with a high proportion of threatened fish, and some rare and endangered fish, such as Chinese sturgeon and Yangtze sturgeon, cannot continue to reproduce naturally. Finally, the functional degradation of the ecosystem is reflected in various aspects, such as wetland destruction and shoreline development (Chun, 2019). The complexity and integrity of the Yangtze River Basin's ecosystem determine that its

ecological environment issues exhibit cross-regional and trans-basin characteristics. Any ecological environmental problem in a particular area can significantly impact the entire Basin; for instance, the eutrophication issue in the Taihu Basin involves the provinces of Zhejiang and Jiangsu. Therefore, it is necessary to address ecological and environmental challenges from a holistic basin perspective. Establishing a collaborative governance model across administrative regions is often regarded as an effective means to prevent the fragmentation of the Basin's ecological integrity and to overcome institutional fragmentation. Since 2021, the Chinese Yangtze River Protection Law has also highlighted the concept of coordinated governance of the Basin, which reflects that basin governance should be carried out from the perspective of a unified ecosystem of the Basin as a whole. The regional collaborative governance model aligns with the holistic, extensive, complex, and multi-faceted nature of ecological and environmental issues in river basins. It addresses the limitations of knowledge, resources, and capacities associated with single-theme governance, promotes the coordination of governance policies and the unification of regulations, and enhances information sharing, resource integration, and action coordination among regions, ultimately fostering a synergistic governance effort. Meanwhile, the regional collaboration forms an environmental protection community that can fundamentally overcome "the collective action dilemma" and solve the problems (Yi et al., 2018). What factors influence the effectiveness of this inter-administrative collaborative governance? What pathways do these factors have on the outcomes of collaborative governance? How can the effective inter-provincial collaborative governance of cross-regional environmental pollution be promoted? Addressing these questions will contribute to further refining the inter-provincial collaborative governance mechanism in river basins and provide insights for implementing the ecological protection and high-quality development strategy in the Yangtze River Basin.

Some frameworks and theories have discussed collaborative governance problems, including the function of collaboration of each subject (Woods and Bowman, 2018), collaborative dilemma (He and Wang, 2018), collaborative network analysis (Jie and Liming, 2019), collaborative governance effectiveness (Minwang, 2022) and the internal and external influencing factors of collaborative governance (Jie and Liming, 2019; Liu et al., 2021) However, there is still little systematic analysis of the influencing factors, and quantitative approaches lack. Previous research in China has examined the impact of internal, external, and process factors on collaborative governance effectiveness (Rao and Zhao, 2022). However, they ignored the complexity of the collaborative problem, which involves complex relationships between multi-level concurrent conditions and outcomes. Ecological and environmental regional collaborative governance is the result of the interplay of various internal and external influencing factors rather than being attributable to any single aspect. It reflects the complex relationship between multi-dimensional concurrent conditions and governance outcomes. Within different combinations of influencing factors, the causal mechanisms between individual influencing conditions and governance effects may vary. Unfortunately, existing research neglected this critical aspect, and the preconditions for inter-provincial collaborative governance under the Chinese Basin have not been fully explored (Chen et al., 2015). Recently, qualitative comparative analysis (QCA) has become a popular tool for explaining complex situations related to collaboration (Jager, 2016; Sedgwick, 2017; Hossu et al., 2018). The governance of the ecological environment in the Yangtze River basin in China is a suitable case for exploring the initial conditions for inter-provincial collaborative governance (Fu et al., 2022). Thus, this study adopts QCA to test for the combinations of preconditions for establishing inter-provincial collaboration governance. The purpose is to identify different paths for establishing inter-provincial collaborative governance and outline different collaboration modes for controlling ecological and environmental problems in the Yangtze River basin in China.

Our research makes several meaningful contributions to the literature on inter-provincial collaborative governance and the study of its influence factors effect. Firstly, we attempt to put forward a new theoretical framework based on the existing research and construct a framework of influencing factors for the effect of inter-provincial collaborative governance with reference to collaborative governance and DBO (expectation-faith-opportunity) theory, as well as the antecedent conditions that can be tested. This study can deepen the understanding of inter-provincial collaborative governance, and future empirical research can further enrich the theoretical framework proposed in this work. Furthermore, we incorporate external contextual variables that influence inter-provincial collaborative governance into the analytical framework, thereby enriching the theoretical discourse on collaborative governance. Additionally, integrating theoretical research on individual behavior into the study of collaborative governance issues can provide new insights for addressing these challenges. Finally, this study contributes to the literature exploration of watershed environmental governance and provides new insights into how regional governments can engage in collaborative governance. The research framework is shown in Figure 1. The remaining parts of the paper are organized as follows: Section 2 establishes a theoretical foundation and analytical framework. Section 3 describes the sample, methods, and measures. Section 4 focuses on the empirical tests and results analysis, including Single factor Necessary Condition Analysis and Configuration analysis. Section 5 presents conclusions and policy recommendations.

2 Theoretical framework

Inter-provincial ecological environmental collaborative governance is an environmental governance model based on the governmental level, which plays a key role as part of many subsystems of cooperative governance (Rao and Zhao, 2022). The roles, interactive behaviors, and interdependencies of government subjects from different sectors, levels, and regions should be fully considered in collaborative governance. Government agencies at all levels should establish non-commissioned relationships, cooperate voluntarily and equally when faced with common interests, coordinate and integrate resources, share risks and benefits, achieve a positive synergy of one plus one greater than two, maximize the overall effectiveness of governance, form a holistic, balanced and mutually supportive system, and tackle issues that individual governments or departments cannot resolve.

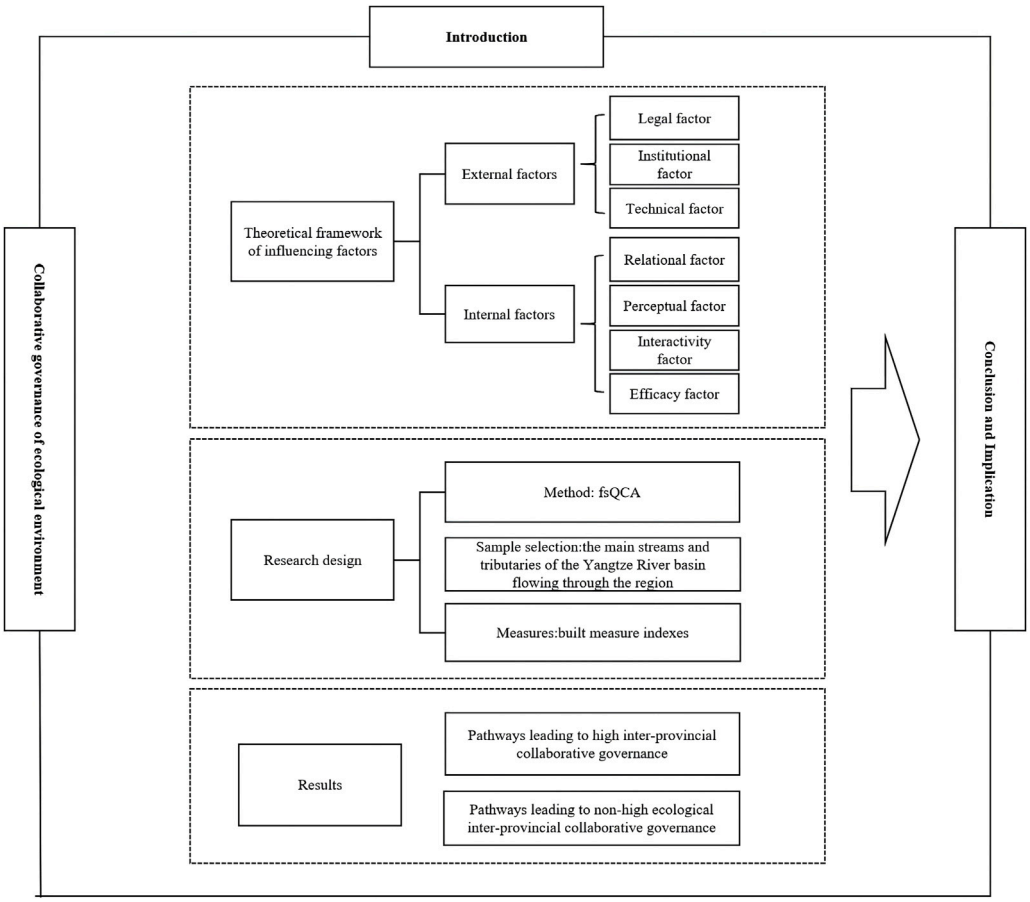

FIGURE 1
Research framework.

The research on influencing factors of collaborative governance can be summarized into internal and external aspects: the main internal influencing factors include collaborative network (Saba et al., 2015), formal cooperation degree (Scott, 2015), and regional collaborative organization (Gerlak and Heikkila, 2006). The main external influencing factors include government support (Mattor and Cheng, 2015), deterioration of environmental problems (Liu et al., 2022), etc. In Western social practices, the primary focus is on the interactions among different participating stakeholders. Research has identified that factors such as previous collaboration experiences, shared beliefs or goals, and resource dependency are key influences on the collaborative motivations of stakeholders (Smith, 2009; Amirkhanyan, 2009). In the Chinese context, the most significant influence on inter-regional governmental collaboration is the top-down institutional arrangements. To achieve specific policy objectives, the central government may employ a range of strategies to intervene in the collaborative behaviors of local governments (Zhou, 2020). Meanwhile, in terms of the ecological environment, the collaborative governance theory holds that the government plays a fundamental role in the governance system. However, there is still a lack of research on the analysis framework of influencing factors of inter-provincial collaborative governance from the perspective of the interaction of internal and external influencing factors. A small number of studies did not divide internal and external influencing factors in detail and analyzed the role of each influencing factor in depth (Mu et al., 2019; Fu et al., 2022). Thus, this paper integrates the core elements of various regional environmental collaborative governance models when discussing the influencing factors of inter-provincial collaborative governance in the Yangtze River Basin. We also introduce Peter Hirstrom's DBO theory of influencing individual behavior, that is, to explain the mechanism with expectations, beliefs, and opportunities, to explain complex social phenomena by breaking down processes and highlighting elements, with the core of exploring a series of social mechanisms that influence the interaction between individuals and others (Herstrom, 2010). Embedding the interactive behavior at the provincial government level in the DBO theory helps to explain two aspects: First, the motivation of the provinces to engage in synergy, which is the direct cause of cooperative behavior; Second, the structured opportunities for connection between provinces, which constrains the actions of subjects and defines the structure of interaction. The theory assumes that behavior arises due to a combination of the intrinsic expectations and beliefs of the actors as well as external opportunities (Shan and Duan, 2022). It is more helpful in analyzing which factors may influence inter-provincial collaborative behavior. To sum up, we construct a theoretical framework (Figure 2) that further categorizes the dimensions of

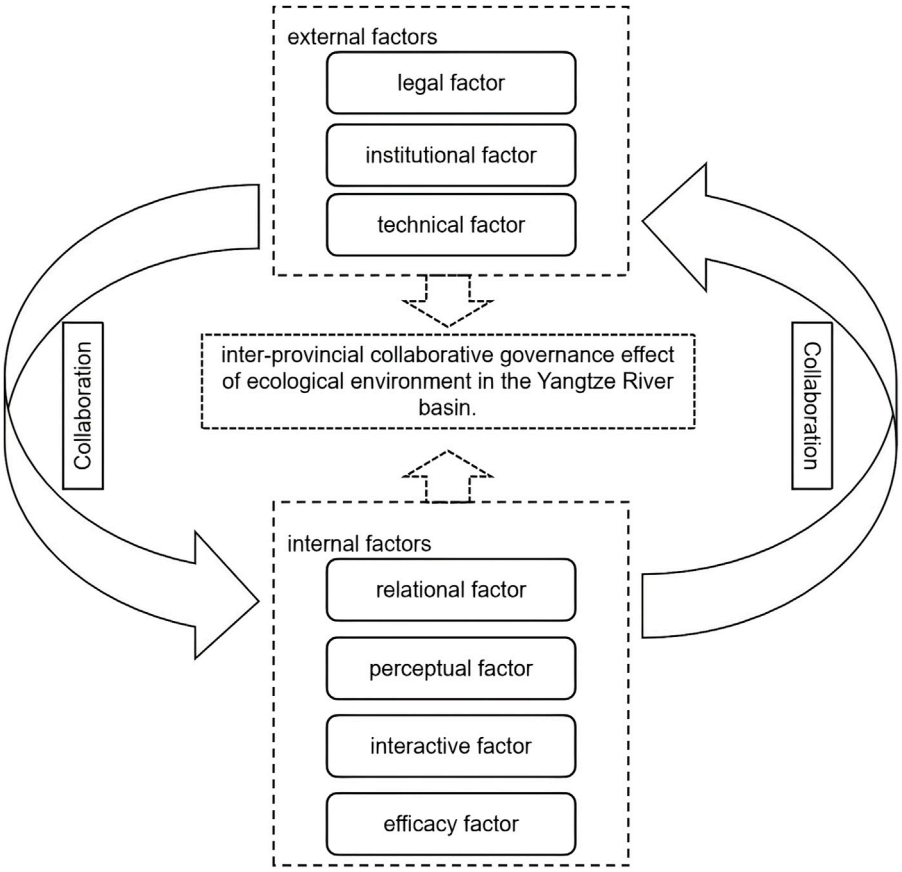

FIGURE 2
Theoretical framework for the influencing factors of inter-provincial collaborative governance of ecological environment in China's Yangtze River basin.

inter-provincial collaborative environmental governance in the Yangtze River Basin into internal and external influences. External factors include legal, institutional, and technical factors, while internal factors include relational, perceptual, interactive, and effectiveness factors.

2.1 External factors

2.1.1 Legal factor

The legal environment reflects the central government's vertical intervention in inter-provincial collaborative governance, with a solid guiding and supervisory function from higher to lower levels of government in China (Mu et al., 2019). The inter-provincial environmental governance laws and regulations formulated by the National People's Congress, the central government, and relevant departments can effectively provide ideas and directions for inter-provincial environmental collaborative governance. They actively encourage provincial governments to adopt cooperative behaviors in dealing with environmental problems and enhance the effectiveness of environmental collaborative governance (Fan, 2011). Therefore, the laws and regulations provide opportunities and motivation for provincial cooperation, which is one of the critical external motivations for the effective development of inter-provincial collaborative governance in the Yangtze River basin.

2.1.1.1 Institutional factor

Institutional factors are shared factors that influence regional collaborative governance and act on each variable of collaborative governance. Specifically, various provincial-level governments within each province establish cooperative mechanisms through autonomous negotiation and take cooperative actions toward achieving unified collaborative goals (Mu et al., 2019). The institutional factor has an integration function, a rational expression of cooperative consensus that can prevent and resolve cooperative conflicts and accelerate the integration process of collaborative governance (Wu and Zhuang, 2013). Institutional factors influence the orderliness of subject relations and the direction of collaborative interaction, which can guarantee the efficient implementation of regional collaboration and maximize the effectiveness of synergy (Wu and Zhuang, 2013). Therefore, it plays a crucial role in exploring the inter-provincial collaborative governance in the Yangtze River basin.

2.1.2 Technical factor

The technical factor refers to various digital technologies that facilitate effective inter-provincial collaboration, and it is a vital

integration tool that can promote collaborative action. In the digital era, digital technologies can realize the dynamic synchronization of regional integration processes and the integration of resources and knowledge across time and space. It makes the connection of subjects in collaborative governance break through physical limitations and become closer. The digital era is gradually changing the collaborative interaction environment and tools of subjects, and various digital platforms greatly enrich the choice of interaction tools and improve the efficiency of interaction. Meanwhile, big data, the Internet of Things, and artificial intelligence can empower ecological environment governance, achieving real-time monitoring, information synchronization and sharing, autonomous decision-making, etc. Therefore, in China's rapidly developing digital economy, it is essential to introduce the impact of technological factors on inter-provincial collaborative governance.

2.2 Internal factors

2.2.1 Relational factor

In the impact factor research, considering subjective judgments and behavioral attitudes of various actors focuses more on the subjective motivation of the cooperating parties. Inter-provincial collaborative behavior should result from the interaction between internal and external factors. Relational factors mainly include trust: the degree of trust of collaborative actors to other participating actors; interdependence: the ability of provincial actors to share resources or strengthen cooperation to strengthen their respective behavioral capabilities; competition: the psychological needs and behavioral activities of actors trying to outperform or overwhelm other actors; emotions: the psychological activities mediated by the desires and needs of actors (Pan, 2015; Tang et al., 2020; Lili et al., 2015). The relational factors among the provinces in the Yangtze River Basin directly affect the attitude of each province toward cooperative behavior and are the vital intrinsic factors for solid cooperation.

2.2.2 Perceptual factor

Perceptual factors include"risk perception: the subjective judgment of collaborative governance actors on the characteristics and severity of ecological problems in the Yangtze River Basin; quality perception: the extent to which actors' sensory needs are met to the quality characteristics of ecological management in the Yangtze River Basin; value perception: The overall evaluation of the utility that the subject perceives from the benefits obtained from the ecological environment governance of the Yangtze River Basin and the costs incurred when obtaining the benefits (Pan, 2015; Tang et al., 2020)." The subjective perception of each province determines the level of contribution to governance, and differences in perception of environmental issues may disrupt the collaborative balance and become an obstacle to effective governance.

2.2.3 Interactivity factor

Interactive factors mainly include interactive communication, dynamic feedback, and timely dialogue behavior between actors; information acquisition, the activity process of actors to obtain original information through technical means and ways means; opinion expression, actors can express their views without hindrance and constraints (Pan, 2015; Yaodan, 2018). Effective and benign interactions among provinces can greatly enhance collaborative efficiency, and the efficient operation of the collaboration mechanism requires institutional safeguards and is closely related to the effective interaction of subjects.

2.2.4 Efficacy factor

Efficacy factors include self-efficacy, the subjective judgment of whether the actor can successfully carry out the ecological environment collaborative management behavior; participation efficacy, the subjective judgment of whether the actor is willing to participate in the ecological environment collaborative management behavior of the Yangtze River Basin (Pan, 2015; Yong, 2019). The subjective judgment of the actors on the ecological and environmental collaborative governance model is the internal motivation to promote cooperation. It is an essential internal factor in maintaining long-term cooperation.

3 Research design

3.1 Sample selection

The qualitative comparative analysis (QCA) method is applied to small-sample scope research. The research object is the inter-provincial collaborative governance of the ecological environment in the Yangtze River basin area. The number of environmental emergencies in a province can directly reflect the effect of the province's participation in inter-provincial collaborative governance. The reduction in the number of incidents indicates that collaborative governance measures have been effective in preventing and controlling environmental risks (Liu et al., 2022). The variation in the frequency of environmental emergencies indirectly reflects the operational status of collaborative governance mechanisms. If the collaborative governance framework is robust and functioning smoothly, provinces can form a concerted effort to address environmental issues, thereby more effectively reducing the occurrence of unexpected environmental events. To ensure a comprehensive and effective comparison of sample types, this study analyzes the information on ecological and environmental collaborative governance published by the environmental protection departments or bureaus of various provinces and cities through their official websites and local media. By correlating this data with the annual frequency of environmental emergencies in each province, we select provinces with varying levels of collaborative governance information dissemination and differing frequencies of environmental incidents. Additionally, we consider the economic development of different provinces and the availability of data. Finally, the study selects the main course and tributaries of the Yangtze River Basin, encompassing 11 provinces, autonomous regions, and municipalities directly under the central government—namely, Qinghai, Tibet, Sichuan, Yunnan, Chongqing, Hubei, Hunan, Jiangxi, Anhui, Jiangsu, and Shanghai. Moreover, hundreds of tributaries extend into parts of eight provinces and autonomous regions, including Guizhou, Gansu, Shaanxi, Henan, Guangxi, Guangdong, Zhejiang, and

Fujian. In total, 19 provincial-level administrative regions are selected as the research sample.

3.2 Method

Qualitative Comparative Analysis (QCA) is a research approach based on set theory that combines qualitative and quantitative analytical methods. This method holds that a certain outcome variable is the outcome of the combined effect of relevant influencing factors. To identify such configurations, QCA conducts a certain number of cross-case comparisons, applies Boolean algebra to reduce the configurations, uncovers various configurations that lead to the outcome variable, and distinguishes between core conditions and non-core conditions (Ragin, 2008). QCA integrates the advantages of qualitative and quantitative research methods. It explores the commonalities across cases on the basis of an in-depth understanding of individual cases, holds that there can be multiple paths to achieve a certain outcome, makes the research more consistent with realistic logic, breaks through the thinking limitations of traditional quantitative research (Yao et al., 2010), and can effectively deal with multiple concurrent causal relationships across cases. At present, a large number of researchers use the QCA method to carry out a variety of management problems (Guo et al., 2023; Park et al., 2020). The effect of inter-provincial collaborative governance of the ecological environment explored in this study is the result of the joint action of internal and external influencing factors, not only caused by one aspect. It reflects the complex relationship between multi-level concurrent conditions and governance effect. Furthermore, the sample size of 19 in this study is considered moderate and does not meet the "large sample" requirements typically associated with quantitative research. However, it aligns well with the requirements of Qualitative Comparative Analysis (QCA), which focuses on medium to small-sample cases. This approach not only enhances external validity but also preserves case heterogeneity and depth (Schneider and Wagemann, 2013). This research selects seven conditional variables: relational factors, perceptual factors, interactive factors, effectiveness factors, legal factors, institutional factors, and technological factors, as well as the effectiveness of inter-provincial collaborative governance in the ecological environment as the outcome variable. For medium-sized sample studies, the ideal number of conditions typically ranges from 4 to 7. Therefore, the selection of seven conditional variables is appropriate.

QCA methods are mainly divided into crisp set QCA and fuzzy set QCA. Among them, the variables in the csQCA set method take the values of 0 and 1, and such a dichotomy is too absolute to meet the meticulous quantitative standards in the social sciences. When describing inter-provincial collaborative governance, the use of "better" or "worse" cannot accurately reflect the real governance effect. However, fsQCA provides an effective means to deal with multiple categorical variables, and the variables of the fuzzy set take a value between 0 and 1. This paper employs the six-value anchor method of fsQCA, assigning variable values of 0, 0.2, 0.4, 0.6, 0.8, and 1. Data analysis and processing are conducted using fsQCA 3.0 software. This approach addresses the reality that the outcome variable does not conform strictly to binary states of 0 and 1, thereby providing a more nuanced representation of real-world conditions compared to csQCA.

3.3 Measures

The fsQCA method is used to analyze the conditional grouping of factors influencing inter-provincial collaborative governance of the ecological environment and to derive multivariate driving paths affecting inter-provincial collaborative governance of the ecological environment in the Yangtze River basin. The method treats each conditional variable and outcome as an ensemble, and each sample data is uniformly associated with a score in the ensemble. Assigning an ensemble affiliation score to the sample data is calibrated. Therefore, we use a 6-value assignment scheme according to the assignment requirements of fsQCA to variables. To reduce the subjectivity of variable assignment, this research uses the Delphi method, and the specific process is as follows: (1) This paper employs a questionnaire survey to gather subjective information regarding the internal factors of the conditional variables. The subjective perceptions and attitudes of government departments towards ecological and environmental issues also influence personnel at various levels within the province. Therefore, we expand the scope of its survey participants, encompassing 40% from administrative units, 23% from non-governmental environmental organizations, 20% from corporate personnel, and 17% from other sectors. All respondents are affiliated with the collaborative institutions of our research team; (2)This paper collects relevant information on the external factors of the conditional variables and the outcome variables. To ensure the completeness and comprehensiveness of inter-provincial agreement data, the collaborative agreement data for this research is sourced from three main channels: first, inter-provincial environmental cooperation agreements are collected from provincial daily newspapers; this involves conducting full-text searches using the Duxiu newspaper database, followed by manual screening. Second, data is gathered and filtered from the official websites of provincial governments and ecological environment bureaus using the same keywords. Finally, yearbook data is utilized to identify any gaps; the significant events section in each province's yearbook records major occurrences and regional exchanges for that year, allowing for the supplementation and enhancement of inter-provincial agreement data. Other main information comes from the China Statistical Yearbook on the environment, portal websites of provincial and municipal environmental protection departments/bureaux, local official media and we-media platforms, and academic papers, and is statistically summarized; (3) Invite several experts from our research team to provide information on the collection of preliminary questionnaires and external factors, and after unifying the assignment rules, consult the experts on the assignment of each variable, organize, summarize and count the assignment opinions, and then anonymously give feedback to the experts, consult again, focus again, and give feedback again, until we get consistent opinions on the assignment of variables. The specific variables and assignment settings are shown in Table 1.

TABLE 1 Variable assignment and setting.

Variable type	Variable name	Variable assignment criteria	Assignment	Source of literature
Result Variables	Effect of inter-provincial collaborative governance of Ecological Environment	Ongoing collaborative governance among provinces, with a low number of environmental emergencies in the past 5 years	1	Shan and Duan (2022), Suo et al. (2017), Li HX et al. (2022)
		Active collaborative management among provinces, the number of environmental emergencies in the past 5 years is average	0.8	
		There is a collaborative governance intention among provinces, but not actively, frequent environmental emergencies in the past 5 years	0.6	
		No cooperation	0	
Conditional Variables	Legal Factors	China has enacted environmental protection-related laws and regulations on various aspects of cross-regional collaborative environmental management rights, and each collaborating province is actively involved and cooperates tacitly	1	Yang M and Li Z. C. (2024), Zhou, 2020; Mu et al. (2019)
		The environmental protection-related laws enacted in China can better guarantee the rights of various aspects of cross-regional collaborative environmental management	0.8	
		The laws enacted in China related to environmental protection can basically guarantee all aspects of the right to collaborative environmental management across regions	0.6	
		The environmental protection-related laws enacted in China do not cover the content related to cross-regional collaborative environmental management	0	
	Institutional factors	The region's environmental inter-provincial collaborative governance-related system is complete; the subjects are closely linked environment, tacit cooperation, open and transparent environmental information	1	Yang M and Li ZC (2024), Zhou, 2020; Fu et al. (2022), Mu et al. (2019)
		The regional inter-provincial cooperation and environmental management system has been standardized, making environmental information more accessible	0.8	
		The region's environmental inter-provincial collaborative governance-related system is basically standardized, and environmental information is basically open	0.6	
		The region does not have a system for inter-provincial cooperation in environmental management, and environmental information is not made public	0	
	Technical Factors	The region has a variety of online platforms for provincial staff to understand and participate in environmental issues, making full use of digital technology to enable inter-provincial collaborative governance, with fast updating of information on each platform and continuous communication among provincial staff	1	Huang and Yin (2022)
		The online platforms for people in the provinces in the region to learn about and participate in environmental issues are rich and diverse, and other provinces are actively involved and communicate more easily and quickly	0.8	
		The region has a multi-faceted platform for people from all provinces to understand and participate in environmental issues	0.6	

(Continued on following page)

TABLE 1 (*Continued*) Variable assignment and setting.

Variable type	Variable name	Variable assignment criteria	Assignment	Source of literature
		There are no multiple channels for provincial personnel to understand and participate in environmental issues in the region	0	
	Perceptual factors	The province is quick to judge the severity of environmental problems in the Yangtze River basin and is satisfied with the quality and demand for environmental management	1	Huang XR (2021), Shi B and Mao HY (2016), Tang et al., 2020; Wu (2017), Zhang QC and Ai LY (2020), Choi and MOYNIHAN (2019), Kang, 2020; Pan (2015)
		The province makes judgments about the severity of environmental problems in the Yangtze River basin and is satisfied with the quality and needs of environmental management	0.8	
		The province made a fundamental judgment about the seriousness of environmental problems in the Yangtze River basin and is partially satisfied with the quality and needs of environmental management	0.6	
		The province has difficulty judging the severity of environmental problems in the Yangtze River basin and is not satisfied with the quality and demand for environmental management	0	
	Efficacy factors	The province is actively involved in the inter-provincial synergy of environmental management and is doing its best to fulfill its mission, believing that this approach will successfully solve environmental problems	1	Li Y (2019), Choi and Moynihan (2019), Mosley and Jarpe, 2019; Pan (2015)
		The province is willing to participate in inter-provincial collaborative environmental governance and to complete the task	0.8	
		There is a willingness in the province to participate in interprovincial synergy in environmental governance, taking partial action	0.6	
		The province is reluctant to engage in inter-provincial synergy in environmental management	0	
	Relational factors	The province has trust in other partner provinces and is willing to share resources or strengthen its behavior to improve cooperation	1	Chen Q, 2018; Huang XR (2021), Li Y, 2019; Jun Ren (2020), Tang et al. (2020), Wang Y (2018), Wang LL et al., 2015; Wu (2017), Zhang CP et al. (2020), Elgin, 2015; Jager et al. (2021), Mosley and Jarpe, 2019; Pan (2015)
		The province has general trust in other cooperating provinces and can provide specific resources	0.8	
		The province's need to cooperate based on the psychological need to compete with other provinces	0.6	
		Lack of trust between provinces and reluctance to share resources and strengthen cooperation	0	
	Interactivity factor	Effective dynamic feedback and timely communication between provinces and access to all information	1	Bai H, 2017; Jun Ren (2020), Shi B & Mao HY (2016), Tang et al. (2020), Wang JL (2017), Weng SH et al., 2020; Wu (2017), Wu CQ (2017), Zhang CP et al. (2020), Jager et al. (2021), Mosley and Jarpe, 2019; Pan (2015), Xing and Xing (2021)
		Dynamic feedback and dialogue between provinces and access to relevant information	0.8	
		Limited dialogue between provinces, with partial but incomplete access to necessary information	0.6	
		The province is hampered in expressing its views on environmental governance and does not have access to information from other cooperating provinces	0	

TABLE 2 Univariate necessity analysis of the factors influencing inter-provincial collaborative governance of the ecological environment in the Yangtze River basin.

Conditional variables	High ecological environment inter-provincial collaborative governance		Non-high ecological environment inter-provincial collaborative governance	
	Consistency	Coverage	Consistency	Coverage
Legal Factors (LF)	0.537	0.83134	0.818	0.628
Non-high legal factors (~LF)	0.729	0.887218	0.818	0.519
Institutional Factors (IF)	0.479	1.000	0.697	0.550
Non-high system factors (~IF)	0.792	0.801	0.978	0.657
Technical Factors (TF)	0.653	0.822	0.788	0.620
Non-high-tech factors (~TF)	0.643	0.955	0.939	0.578
Perceptual factors (PF)	0.722	0.877	0.742	0.467
Non-high perceptibility factor (~PF)	0.504	0.781	0.788	0.612
Efficacy Factor (EF)	0.567	0.924	0.697	0.575
Non-high performance factors (~EF)	0.692	0.810	0.899	0.545
Relational Factors (RF)	0.685	0.831	0.879	0.537
Non-high relationality factors (~RF)	0.574	0.892	0.727	0.585
Interactivity Factor (IAF)	0.685	0.848	0.788	0.605
Non-high-interactivity factors (~IAF)	0.630	0.954	0.839	0.596

4 Results

4.1 Single factor necessary condition analysis

The necessity test for the condition variables affecting inter-provincial collaborative governance of the high ecological environment and the non-high ecological environment is shown in Table 2. The results show that the consistency coefficients of all the condition variables of inter-provincial collaborative governance of the high ecological environment are less than 0.9, indicating that none of the seven antecedent conditions is necessary to constitute inter-provincial collaborative governance of the high ecological environment. The result verifies the combinatorial nature of the drivers of inter-provincial collaborative governance of the ecological environment in the Yangtze River basin, driven by a complex system in which no single factor has a significant role, and the driving paths are multiple. Table 2 shows that the lack of institutional factors (~IF, consistency 0.978342) and technical factors (~TF, consistency 0.939394) is necessary for inter-provincial collaborative governance of a non-high ecological environment. This result inverse proves the vital role of institutional and technological factors in inter-provincial collaborative governance.

4.2 Configuration analysis

The research used fsQCA 3.0 software to analyze 19 cases of data, and the consistency threshold was set to 0.8 based on the number of sample cases and the fsQCA analysis convention (Fu et al., 2022). The results of the fsQCA analysis include complex, intermediate, and parsimonious solutions. Among them, those appearing in intermediate and parsimonious solutions are core conditions, and those appearing only in intermediate solutions are edge conditions. We mainly analyze the results of intermediate solutions and consider the effects of core and edge conditions.

From Table 3, the research identified three pathways leading to high inter-provincial collaborative governance of the ecological environment. Based on the coverage of the solutions, it is clear that these three solutions explain a total of 82.2% of the inter-provincial collaborative ecological governance samples in the Yangtze River basin. According to the difference of sufficient conditions, as shown in Figure 3, the modes of ecological environment inter-provincial collaborative governance can be summarized into three types: technology empowers relationship driving, institution reinforces interactive driving, and internal and external interactive driving.

4.2.1 Technology empowers relationship driving

Path H1: perceptual factors * relational factors * interactive factors * technical factors * ~ legal factors * ~ institutional factors. The path suggests that in the inter-provincial collaborative ecological and environmental governance of the Yangtze River basin, regardless of the presence of efficacy factors in the province, having a high perception of the severity of environmental problems, solid relationships and close interaction with cooperating provinces, and active application of digital technologies will achieve high inter-provincial collaborative ecological and environmental governance effects, even if legal and institutional factors are lacking. Studies have emphasized the central conditional role of horizontal coordination and agreements among provinces. The pathway further found the importance of

TABLE 3 Configuration analysis of ecological environment inter-provincial collaborative governance for high and non-high.

Conditional variables	High ecological environment inter-provincial collaborative governance			Non-high ecological environment inter-provincial collaborative governance	
	H1	H2	H3	NH1	NH2
Legal Factors (LF)	⊗	⊗	●	⊗	⊗
Institutional Factors (IF)	⊗	●	⊗	⊗	⊗
Technical Factors (TF)	●	⊗	●	●	⊗
Perceptual factors (PF)	●	●	●	⊗	●
Efficacy Factor (EF)		●	●	⊗	⊗
Relational Factors (RF)	●	⊗	●		⊗
Interactivity Factor (IAF)	●	●	⊗	⊗	●
raw coverage	0.365	0.182	0.291	0.576	0.561
Unique coverage	0.063	0.024	0.046	0.030	0.061
consistency	1.000	0.916	1.000	0.826	0.822
solution coverage	0.822	0.673			
solution consistency	0.973	0.902			

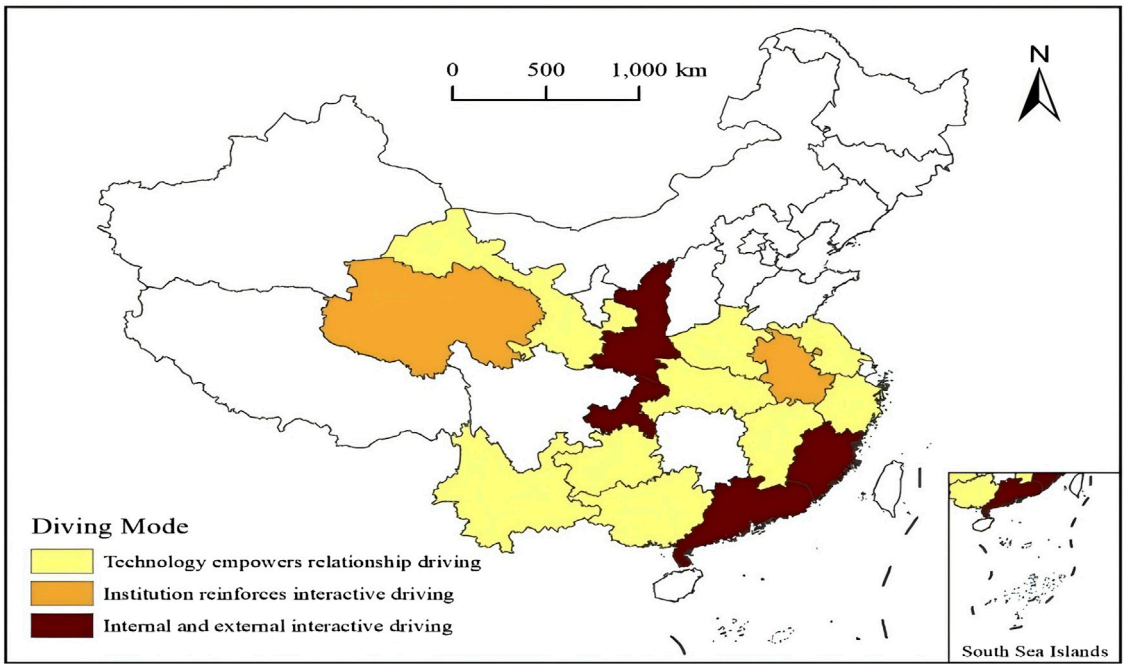

FIGURE 3
Driving mode of inter-provincial collaborative governance of ecological environment in China's Yangtze River Basin.

intrinsic motivation. Moreover, technological factors can enhance internal motivations. Applying digital technology can further deepen environmental perceptions, relationships, and interactions among provinces by breaking the geographical limitations of communication and interaction among provinces and barriers to information sharing, enriching the understanding and awareness of provinces about the severity of ecological and environmental problems and may evolve new modes of cooperation that enhance the effectiveness of ecological and environmental governance.

The representative province of this path is Guangxi Zhuang Autonomous Region. In terms of the internal factors questionnaire survey, Guangxi Autonomous Region scored an average of 3.4 for perceived factors (ranking second among all provinces), 3.65 for relational factors (ranking fourth), and 3.33 for interactive factors (ranking fifth), ranking within the top 30% of all provinces. At the same time, digital technologies are fully utilized to assist ecological collaborative governance. The Yulin Jiu Zhoujiang River Basin ecological environment big data platform has been established, and advanced new technologies such as big data and cloud computing have been fully utilized to promote information sharing on pollution sources, pollutants, and ecological environmental quality. The environmental governance level of crucial river basins and regions has continuously improved, and the monitoring, evaluation, and service capabilities for ecological protection have enhanced. Under the regional information interaction empowered by technology, the excellent rate of surface water quality in the entire region has been maintained at over 96% for five consecutive years.

4.2.2 Institution reinforces interactive driving

Path H2: perceptive factors * institutional factors * interactive factors * effectiveness factors * ~ legal factors * ~ relational factors * ~ technical factors. The path indicates that, within the collaborative environmental governance of the Yangtze River Basin, a province that exhibits a keen awareness of environmental issues, maintains tight communication with cooperating provinces, actively engages in inter-provincial collaborative environmental governance frameworks, and establishes an effective mechanism for inter-provincial cooperation. The province can still attain remarkable ecological and environmental governance outcomes despite lacking legal, relational, and technical support. Institutional factors impose strong constraints on inter-provincial interaction; meanwhile, the process of close interaction can consolidate and improve cooperation mechanisms. In addition, high awareness of environmental issues and full recognition of collaborative governance models by each province, combined with policies related to ecological and environmental governance within each province, can achieve collaborative effects. It can compensate for deficiencies in inter-provincial relations and technology, ultimately promoting ecological and environmental governance.

The representative province of this path is Anhui Province. In terms of internal factors questionnaire survey, Anhui Province scored an average of 3.4 for perceived factors (ranking first among all provinces), 3.47 for interactive factors (ranking third), and 3.25 for efficiency factors (ranking fifth), all ranking within the top 30% of all provinces. In the past 5 years, establishing a collaborative governance mechanism in Anhui Province has exhibited an inside-out development trend. It has been demonstrated through the signing of various agreements, such as ecological and environmental governance cooperation agreements between cities and departments, environmental protection loan cooperation agreements between the provincial Department of Finance and the provincial Department of Environmental Protection, and four cooperative banks in the province, as well as the convergence of two laws on administrative law enforcement and criminal justice for environmental protection. Furthermore, Anhui Province has signed cooperation agreements with Nanjing City, Nanjing Institute of Environmental Science, Shanghai Jiading District, Xuzhou City, Hangzhou City, and the Huaihai Sea Economic Zone to set up a collaborative development of ecological environment joint prevention and control cooperation framework agreement. Additionally, the province has signed a strategic cooperation agreement with Tsinghua University Hefei Institute of Public Security to help promote the transformation of innovative achievements. These efforts have helped to improve the ratio of excellent sections for the province's Yangtze River basin water quality to 94.8% and the public's satisfaction rate for the ecological environment to 92.8%.

4.2.3 Internal and external interactive driving

Path H3: perceptual factors * relational factors * efficacy factors * legal factors * technical factors ~ interactional factors * ~ institutional factors. The path indicates that despite potential deficiencies in interactional and institutional factors in inter-provincial collaborative ecological and environmental governance within the Yangtze River Basin, significant effectiveness can still be achieved through a robust awareness of environmental challenges, close partnerships with cooperating provinces, a strong commitment to active participation in the model, the practical application of digital technologies, and comprehensive laws and regulations. External factors and internal factors can complement each other. Legal factors provide an opportunity and guarantee for constructing the inter-provincial collaborative governance model, reflecting the guiding role. Moreover, the close relationship between provinces and their own perception and efficiency factors promotes the elaboration of the implementation of the inter-provincial collaborative governance model of ecological environment, which helps each province clarify its positioning in this model and better play its role. In continuous cooperation, with strong relationship coordination and conflict running, the collaborative governance model can play a better role in ecological and environmental governance.

The representative province of this path is Chongqing. In terms of internal factors questionnaire survey, Chongqing scored an average of 3.19 for perceived factors (ranking seventh among all provinces), 3.54 for relational factors (ranking sixth), and 3.75 for efficiency factors (ranking first), all ranking within the top 40% of all provinces. Since the enactment of the "Yangtze River Protection Law," Chongqing has continuously explored new models of joint enforcement and promoted joint enforcement of the water environment in various city departments. Particular inter-provincial ecological and environmental joint enforcement actions were also carried out in Sichuan and Chongqing, and the inter-provincial synergy model was refined under the guidance of the law. Regarding technical factors, the Chongqing Ecological Environment Big Data Application Center has jointly developed and established the "Basin Water Environment Intelligent Management Platform" with relevant research institutes and universities to achieve the sharing and real-time monitoring of ecological environment information. Under the driving mode of interaction between internal and external factors, the water quality of 74 state-controlled sections of the Yangtze River reached 98.6%, and a total of 1,424 small hydropower plants in the Yangtze River Economic Zone were cleaned up and rectified, with 242 being removed.

When comparing the three paths of technology-enabled relational drive, system-enhanced interactive drive, and internal-external interaction drive, we observe that perceptual factors are common action conditions. Thus, each province's perception and awareness of the severity of ecological and environmental problems and environmental quality are crucial factors in promoting cooperative ecological and environmental governance.

Meanwhile, we identified two pathways leading to non-high ecological inter-provincial collaborative governance. Based on the coverage of the solutions, these three solutions explain a total of 67.3% of the inter-provincial collaborative ecological environmental governance samples in the Yangtze River basin. Path NH1: ~perceptual factors*~institutional factors*~interactive factors*~effectiveness factors*~legal factors*technical factors. This path shows that even if digital technology is actively adopted, the lack of external factors of institutional and legal factors, internal factors of perception of environmental problems, close interaction, and willingness of provinces to participate in collaborative governance actively still leads to non-high inter-provincial collaborative eco-environmental governance effects. Path NH2:~technical factors*~legal factors*~institutional factors*~relational factors*~effectiveness factors*interaction factors*perception factors. This path shows that even with a stronger perception of environmental problems and close interaction among provinces, the lack of external factors of technical, legal, and institutional factors, and internal factors of stronger relational and participatory environmental collaborative governance effectiveness still lead to non-high ecological inter-provincial collaborative governance effects.

5 Discussion and policy implications

5.1 Discussion

Based on the DBO theory and collaborative governance theory, we propose seven antecedent conditions affecting the establishment of inter-provincial collaboration: legal factors, institutional factors, technological factors, perceptual factors, efficacy factors, relational factors, and interactive factors. Focusing on the factors influencing the inter-provincial collaborative governance of the ecological environment in China's Yangtze River Basin, we used 19 provincial-level administrative regions in the Yangtze River Basin as research samples. We refined the inter-provincial collaborative governance paths using qualitative comparative analysis and analyzed the paths using the relevant case materials to demonstrate the characteristics of different paths.

(1) This paper identifies different paths to establish inter-provincial collaborative governance of the ecological environment, Outlines different collaborative models to establish control of ecological environment problems, enriches the results of collaborative governance theory, and represents a meaningful advance in the literature. This paper finds three pathways driving inter-provincial collaborative governance of the ecological environment in the Yangtze River Basin.

First, technology empowers relationship driving and involves the interactive alignment of technological factors with perceptual, relational, and interactive factors. This pathway confirms the empowering role of digital applications in cross-provincial collaborative governance models (Huang and Yin, 2022) and further emphasizes the significance of digital applications in collaborative governance based on existing research (Zhou, 2020; MU et al., 2019; Fu et al., 2022). Digital technologies provide technical support for the interconnectivity of information among provinces, enhancing communication efficiency among government departments at various levels both within and outside the provinces, thereby ensuring the smooth operation of the collaborative governance system. Furthermore, this pathway underscores the critical role of social factors in promoting the effectiveness of collaborative governance within the Chinese context, in addition to formal institutional norms (Huang and Yin, 2022). When aligned with technical support, these social factors can significantly enhance the outcomes of inter-provincial collaborative governance, further enriching the discussion on the influencing factors of collaborative governance.

Second, the institutions reinforce interactive driving, which involves the synergistic alignment of institutional factors with perceptual, effectiveness, and interactive factors. This pathway aligns with the influencing factors proposed in existing research, clarifying the core role of formal institutional regulations in the construction and smooth operation of collaborative governance models (Zhan and Chen, 2020). However, this study provides a more detailed analysis that the stronger the perception of the participants of collaborative governance on ecological environment problems, the stronger the efficiency of the collaborative governance model, and the closer the interaction between them, the easier it is to promote the effect of the inter-provincial collaborative governance under the existing institutional environment and refine the analysis of the driving path of collaborative governance.

Finally, the internal and external interaction driving involves the synergistic alignment of legal factors and technological factors with perceptual, effectiveness, and relational factors. This pathway further indicates that central government supervision is crucial for strengthening regional collaborative governance (Chang et al., 2022). However, higher-level governments often struggle to identify the horizontal interactions needed among participants and are unable to provide guidance. Existing research has found that vertical interventions or centralized organizational arrangements may undermine the autonomous horizontal collaboration of participating entities. The results of this paper indicate that vertical intervention through legal factors alone does not significantly enhance the effectiveness of collaborative governance; rather, it requires interaction with the internal influencing factors of participating entities to achieve meaningful outcomes. The framework of internal influencing factors constructed in this study plays a supportive role in assisting higher-level government decision-making, strengthening horizontal collaboration, and promoting the effectiveness of collaborative governance.

(2) Through the results of Qualitative Comparative Analysis (QCA), this study finds that perceptual factors are key

drivers of inter-provincial collaborative governance in the ecological environment of the Yangtze River Basin. This finding enhances the existing exploration of the influencing factors on inter-provincial collaborative governance in ecological contexts and clarifies the importance of internal influencing factors (Shan and Duan, 2022). When comparing the three paths of technology-enabled relational drive, system-enhanced interactive drive, and internal-external interaction drive, we find that the perceptual factors are the common conditions, which reflects that each province's independent judgment on the severity of ecological and environmental problems in the Yangtze River Basin, the degree of sensory needs for environmental governance quality, and the overall evaluation of the effectiveness of inter-provincial collaborative governance model play a core role in promoting the effect of inter-provincial collaborative governance of ecological environment. It is an important source of motivation for all participants to participate in collaborative governance. Maintaining perceptual factor one causes regional governments to have specific common goals and interests, that is, to reduce environmental pollution and negative externalities through collaborative governance. This view is in line with Richie et al. (2012) that shared goals and interests play an important role in promoting intergovernmental cooperation. Provinces with severe environmental pollution have a high demand for environmental governance. In contrast, provinces with low environmental pollution face negative externalities from neighboring regions and have a high demand for inter-provincial cooperation. Driven by these common goals, it is easier to promote the rapid construction and operation of collaborative governance mode.

(3) Previous studies have explored the internal and external influencing factors of inter-provincial collaborative governance of the ecological environment (Fu et al., 2022). This study puts it under the same framework, and an in-depth analysis finds that external factors and internal factors play different roles in the inter-provincial collaborative governance of the ecological environment, which deepens the conclusion of the discussion of influencing factors.

Comparing the NH1 and NH2 paths and combining the three paths driving inter-provincial collaborative governance reveals that the absence of external institutional, legal, and technological factors is the dominant factor leading to ineffective inter-provincial collaborative governance. However, external institutional, legal, and technological factors are not the core conditions leading to high inter-provincial collaborative governance, and internal perception, relationship, interaction, and effectiveness factors exist as the core conditions enhancing Internal perceptions, relationships, interactions, and effectiveness factors exist as the core conditions that enhance the effectiveness of inter-provincial collaborative ecological governance. Hence, external factors are the guarantee factors of the inter-provincial collaborative ecological governance model and do not necessarily enhance the effectiveness of inter-provincial collaborative ecological governance. However, their absence inevitably leads to the failure of the collaborative governance model and its ineffectiveness. Internal factors exist as motivating factors for the inter-provincial collaborative ecological and environmental governance model, and their enhanced effects will continuously improve the inter-provincial collaborative ecological and environmental governance effect. The role of internal and external factors should be discussed separately, and the incentive role of internal factors can enhance or not enhance the effect of the inter-provincial ecological and environmental collaborative governance model; in contrast, the guarantee role of external factors can inhibit or suppress the effect of the inter-provincial ecological and environmental collaborative governance model. When both internal and external factors are satisfied together, they can complement each other to form a synergy, i.e., three driving paths, which effectively promote the collaborative governance model; when both internal and external factors have only one moment, they will produce conflicts and weaken the final inter-provincial collaborative governance model effect; when both internal and external factors are missing, the inter-provincial collaborative governance model cannot be effectively implemented and cannot achieve the ecological environment management In the absence of both internal and external factors, the inter-provincial collaborative governance model cannot be effectively implemented and cannot achieve the purpose of ecological environment management. As shown in Figure 4. Putting these two factors in the same framework to explore the impact on the effect of inter-provincial collaborative governance of ecological environment further enriches the theoretical framework of influencing factors of collaborative governance. It clarifies the position of factors at the two levels in the theoretical framework.

5.2 Policy implications

(1) Strengthen digital technology embedding and promote interconnection among provinces in the Yangtze River Basin. One of the purposes of inter-provincial cooperation is to break the *status quo* of "information silos" in each province. Each province should pay attention to taking advantage of the national vigorous development of the digital economy to empower itself and inter-provincial cooperation in ecological and environmental governance and use digital information platforms to build two-way information interaction and communication mechanisms to continuously deepen the level of trust and team cohesion among cooperating provinces, so as to provide sufficient information support for each province to make decisions on environmental issues. We will use the digital information platform to build a two-way information interaction and communication mechanism, continuously deepen the level of trust and team cohesion among the cooperating provinces, provide sufficient information support for each province's decision-making on environmental issues, further promote the interconnection of the provinces in the Yangtze River Basin, and bring into play the real effect of collaborative governance.

(2) Pay attention to the differences in environmental quality needs and perceptions of environmental problems among the provinces in the Yangtze River basin and specific analysis of specific problems. This paper analysis shows that perceptive factors co-exist in the three driving paths, so when establishing cooperative relationships, the differential environmental problem perceptions among provinces will

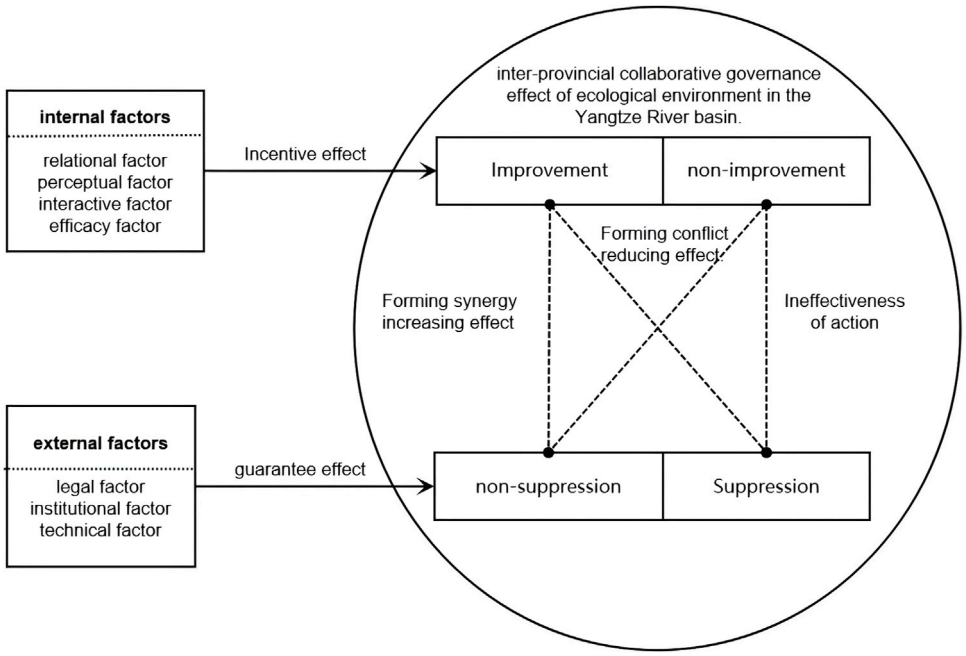

FIGURE 4
Impact of influencing factors of inter-provincial collaborative governance of ecological environment in the Yangtze River basin.

lead to problems such as uneven environmental inputs, weak cooperation intensity, and differences in environmental governance preferences when collaborative governance is established, and provinces should focus on reaching consensus on the severity of environmental problems and environmental governance quality, and cultivate self-organization of provinces in the face of complex ecological and environmental problems The provinces should focus on reaching a consensus on the seriousness of environmental problems and the quality of environmental governance, and cultivate the self-organization and self-adaptation ability of each province in the face of complex ecological and environmental problems so that they can quickly identify environmental crises. At the same time, each province should also analyze specific problems according to its own actual ecological and environmental situation and sign cooperation agreements that should have the specificity of each province's problems, respect the autonomy of local governments, seek common ground while reserving differences, and not ignore differences.

(3) Use the role of internal and external factors to make them form a synergy and enhance the effect of inter-provincial collaborative ecological and environmental governance. Provinces should make use of the role of external institutional, legal and technical factors to ensure that collaborative governance is carried out in an orderly manner and has procedural measures to resolve conflicts and deviations when they occur. At the same time, provincial governments should fully mobilize all provincial departments to participate in collaborative governance, pay attention to the awareness cultivation of the important role of the inter-provincial collaborative governance model, and continuously promote information interaction and close contact among provinces to make inter-provincial collaborative governance better and more effective. Ultimately, the direction of internal and external factors should always be consistent to form a joint effort to improve the ecological and environmental governance effect vigorously.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

YX: Data curation, Formal Analysis, Investigation, Methodology, Writing–original draft. ZT: Funding acquisition, Resources, Supervision, Writing–review and editing. CD: Conceptualization, Data curation, Investigation, Methodology, Writing–original draft.

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Conflict of interest

The authors declare no conflict of interest with any financial organizations regarding the material reported in this manuscript.

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References

Amirkhanyan, A. A. (2009). Collaborative performance measurement: examining and explaining the prevalence of collaboration in state and local government contracts. *J. Public Adm. Res. Theory* 19 (3), 523–554. doi:10.1093/jopart/mun022

Bai, H. (2017). *Research on government information disclosure from the perspective of crisis management: an investigation of government behavior based on 113 public emergencies*. Master's thesis. Hunan Agricultural University (Master's thesis). Available at: https://kns.cnki.net/KCMS/detail/detail.aspx?dbcode=CMFD&dbname=CMFD201702&filename=1017039594.nh.

Chang, Y., Hu, P., Huang, Y., and Duan, Z. (2022). Effectiveness and heterogeneity evaluation of regional collaborative governance on haze pollution control: evidence from 284 prefecture-level cities in China. *Sustain. Cities Soc.* 86, 104120. doi:10.1016/j.scs.2022.104120

Chen, B., Suo, L., and Ma, J. (2015). A network approach to interprovincial agreements: a study of pan-pearl river delta in China. *State Local Gov. Rev.* 47 (03), 181–191. doi:10.1177/0160323x15610384

Chen, Q. (2018). *Research on the intention of citizens to participate in urban public crisis management based on the theory of planned behavior*. Master's thesis. North China University of Science and Technology Master's thesis. Available at: https://kns.cnki.net/KCMS/detail/detail.aspx?dbcode=CMFD&dbname=CMFD201801&filename=1017742050.nh.

Choi, I., and Moynihan, D. (2019). How to foster collaborative performance management? Key factors in the US federal agencie. *Public Manag. Rev.* 3, 36–58. doi:10.1080/14719037.2019.1571275

Chun, L. (2019). Reflections on some major key issues of grasping the Yangtze River together. *J. Henhai Univ. Nat. Sci. Ed.* 47 (04), 283–295. doi:10.3876/j.issn.1000-1980.2019.04.001

Elgin, D. J. (2015). Cooperative interactions among friends and foes operating within collaborative governance arrangements. *Public Adm.* 3 (92), 326–343. doi:10.1111/padm.12167

Fan, O. (2011). *Research on environmental cross-domain governance in China*. China University of Political Science and Law.

Fu, C., Xu, Y., and Zhou, F. (2022). Environmental collaborative governance of urban agglomeration in China: influencing factors and drivers. *Environ. Sci. Pollut. Res.* 30 (13), 38363–38379. doi:10.1007/s11356-022-24769-w

Gerlak, A., and Heikkila, T. (2006). Comparing collaborative mechanisms in large-scale ecosystem governance. *Nat. Resour. J.* 46 (03), 657–707. doi:10.1089/jwh.2006.15.599

Guo, K., Zhang, T., Liang, Y., al, e., and Zhang, X. (2023). Research on the promotion path of green technology innovation of an enterprise from the perspective of technology convergence: configuration analysis using new energy vehicles as an example. *Environ. Dev. Sustain* 25 (6), 4989–5008. doi:10.1007/s10668-022-02253-2

He, D., and Wang, K. (2018). Regional cooperation in China: dilemma, causes and legal regulation. *Urban Plan.* (11), 64–70. doi:10.11819/cpr20181108a

Herstrom, P. (2010). *Analyzing society: principles of analytical sociology*. Nanjing: Nanjing University Press.

Hossu, A. C. C. I., Ioja., Susskind, L. E., Badiu, D. L., and Hersperger, A. M. (2018). Factors driving collaboration in natural resource conflict management: evidence from Romania. *Ambio* 47 (07), 816–830. doi:10.1007/s13280-018-1016-0

Huang, X. (2021). "Research on multi-agent collaborative governance mechanism and Operation evolution of pneumoconiosis in China,". PhD thesis (China University of Mining and Technology PhD thesis). doi:10.27623/d.cnki.gzkyu.2020.000610

Huang, Y., and Yin, W. (2022). The connotation and influencing factors of co-production in ecological environment governance. *J. Hebei Inst. Environ. Eng.* 32 (4), 69–74. doi:10.13358/j.issn.2096-9309.2021.1211.01

Jager, N. W., Newig, J., Challies, E., and Kochskämper, E. (2021). Corrigendum to: pathways to implementation: evidence on how participation in environmental governance impacts on environmental outcomes. *J. Public Adm. Res. Theory* 31 (3), 616. doi:10.1093/jopart/muab006

Jager, W. N. (2016). Transboundary cooperation in European water governance: a set-theoretic analysis of international river basins. *Environ. Policy Gov.* 26 (04), 278–291. doi:10.1002/eet.1717

Jie, M., and Liming, S. (2019). Inter-city cooperation on environmental governance: actions, networks and their evolution--an analysis of inter-prefectural agreement data based on 30 cities in the Yangtze River Delta. *China Adm.* (09), 41–49. doi:10.19735/j.issn.1006-0863.2019.09.06

Jun Ren (2020). "Doctor-patient harmony satisfaction evaluation and multi-subject collaborative governance mechanism research," in *Master's thesis*. Hangzhou Normal University. Available at: https://kns.cnki.net/KCMS/detail/detail.aspx?dbcode=CMFD&dbname=CMFD202001&filename=1019666823.nh.

Kang, S. C. (2020). Volunteer use as a service delivery alternative: the case of law enforcement agencies. *Adm. and Soc.* 00, 248–272. doi:10.1177/0095399720949856

Li, H., Wang, X., and Liu, L. (2022). Does Inter-government cooperation Help improve regional environmental governance performance? - analysis based on the perspective of structural differences. *Econ. Restruct.* 2, 18–25. Available at: https://kns.cnki.net/KCMS/detail/detail.aspx?dbcode=CJFQ&dbname=CJFDLAST2022&filename=JJTG202202003

Li, Y. (2019). *Research on the influence of government trust on political participation: mechanism and trend analysis*. *PhD thesis*, Zhejiang University. Available at: https://kns.cnki.net/KCMS/detail/detail.aspx?dbcode=CDFD&dbname=CDFDLAST2022&filename=1019106675.nh

Lili, W., Bo, L., and Yiliang, Y. (2015). An empirical study on the collaborative behavior of local government network governance. *J. Beijing Univ. Technol. Soc. Sci. Ed.* 17 (01), 53–61. doi:10.15918/j.jbitss1009-3370.2015.0108

Liu, Y., Wu, J., Yi, H., and Wen, J. (2021). Under what conditions do governments collaborate? A qualitative comparative analysis of air pollution control in China. *Public Manag. Rev.* 23 (11), 1664–1682. doi:10.1080/14719037.2021.1879915

Liu, Z., Jia, X., and Pan, M. (2022). Research on the practice and path of inter-provincial cross-domain collaborative governance of ecological environment. *Essays Dongyue* 43 (11), 184–190. doi:10.15981/j.cnki.dongyueluncong.2022.11.018

Mattor, K. M., and Cheng, A. S. (2015). Contextual factors influencing collaboration levels and outcomes in national forest stewardship contracting. *Rev. Policy Res.* 32 (06), 723–744. doi:10.1111/ropr.12151

Minwang, L. (2022). How collaborative environmental governance actions can improve environmental performance: an analytical framework and research agenda. *China Popul. Resour. Environ.* 32 (05), 96–105. doi:10.12062/cpre.20220114

Mosley, J. E., and Jarpe, M. (2019). How structural variations in collaborative governance networks influence advocacy involvement and outcomes. *Public Adm. Rev.* 8, 243–255. doi:10.1111/puar.13037

Mu, R., Jia, J., and Li, P. (2019). Research on the influencing factors of environmental cooperation effectiveness in urban agglomerations. *China Popul. Resour. Environ.*, 8(29), 12–19. doi:10.12062/cpre.20190324

Pan, S. (2015). *To participate or not to participate: a study of public network participation in natural disaster risk communication*. Wuhan University.

Park, Y., Fiss, P. C., and El Sawy, O. A. (2020). Theorizing the multiplicity of digital phenomena: the ecology of confgurations, causal recipes, and guidelines for applying QCA. *MIS Q.* 44 (04), 44. doi:10.25300/MISQ/2020/13879

Ragin, C. C. (2008). *Redesigning social inquiry: fuzzy sets and beyond by charles C.* Ragin University of Chicago Press.

Rao, C., and Zhao, S. (2022). Influencing factors and pathways of cross-domain environmental pollution inter-governmental collaborative management effects--a qualitative comparative analysis based on 12 cases. *J. Central China Normal Univ. Soc. Sci.* 61 (04), 51–61. doi:10.19992/j.cnki.1000-2456.2022.04.006

Richie, L., Oppenheimer, J. D., and Clark, S. G. (2012). Social process in grizzly bear management: lessons for collaborative governance and natural resource policy. *Policy Sci.* 45 (3), 265–291. doi:10.1007/s11077-012-9160-z

Saba, N. S., Julia, L. C., Koski, C., and Sadiq, A. (2015). How policy rules shape the structure and performance of collaborative governance arrangements. *Public Adm. Rev.* 75 (04), 536–547. doi:10.1111/puar.12352

Schneider, C. Q., and Wagemann, C. (2013). Doing justice to logical remainders in QCA: moving beyond the standard analysis. *Political Res. Q.* 66 (01), 211–220. doi:10.1177/1065912912468269h

Scott, T. (2015). Does collaboration make any difference? Linking collaborative governance to environmental outcomes. *J. Policy Analysis Manag.* 34 (03), 537–566. doi:10.1002/pam.21836

Sedgwick, D. (2017). Building collaboration: examining the relationship between collaborative processes and activities. *J. Public Adm. Res. Theory* 27 (02), 236–252. doi:10.1093/jopart/muw057

Shan, S. N., and Duan, X. (2022). Influencing factors and action paths of collaborative governance behavior of multiple subjects in public crisis from the perspective of complexity: a dual analysis based on meta-analysis and fuzzy set QCA. *Public Adm. Policy Rev.* 11 (1), 104–119. Available at: https://kns.cnki.net/KCMS/detail/detail.aspx?dbcode=CJFQ&dbname=CJFDLAST2022&filename=GGZC202201010

Shi, B., and Mao, H. Y. (2016). Research on the influencing factors of social media users' information adoption behavior in public crisis. *Inf. Sci.* 34 (8), 36–41. doi:10.13833/j.cnki.is.2016.08.007

Smith, C. R. (2009). Institutional determinants of collaboration: an empirical study of county open-space protection. *J. Public Adm. Res. Theory* 19 (1), 1–21. doi:10.1093/jopart/mum037

Suo, L., Ma, J., and Chen, B. (2017). Bilateral cooperation and Multilateral coordination in regional environmental governance: an analysis based on the Pan-Pearl River Delta Agreement from 2003 to 2015. *Fudan Public Adm. Rev.* 1, 149–172. Available at: https://kns.cnki.net/KCMS/detail/detail.aspx?dbcode=CCJD&dbname=CCJDLAST2&filename=FDGG201701008

Tang, Z., Zhou, W., Wang, Y., and Li, X. (2020). Public participation in public crisis events in the context of big data: an empirical analysis based on the COVID-19 epidemic. *Library* 8, 33–40. Available at: https://kns.cnki.net/KCMS/detail/detail.aspx?dbcode=CJFQ&dbname=CJFDLAST2020&filename=TSGT202008005

Wang, J. L. (2017). Empirical analysis on the influencing factors of public crisis in network society. *Library*, 5, 40–46. Available at: https://kns.cnki.net/KCMS/detail/detail.aspx?dbcode=CJFQ&dbname=CJFDLAST2017&filename=TSGT201705008

Wang, L., Liu, B., and Yao, Y. (2015). An Empirical study on collaborative behavior of local government network governance. *J. Beijing Inst. Technol. Soc. Sci. Ed.* 17 (1), 53–61. doi:10.15918/j.jbitss1009-3370.2015.0108

Wang, Y. (2018). Research on the influencing factors of the synergistic relationship between government and social organizations in jiangbei District of chongqing. *Master's Thesis, S*. Available at: https://kns.cnki.net/KCMS/detail/detail.aspx?dbcode=CMFD&dbname=CMFD201801&filename=1017846156.nh.

Weng, S., Lin, C., and Zao, K. K. (2020). *Evaluation of the quality of government data opening in emergencies: an empirical analysis of the COVID-19 epidemic in China*, 5. E-government, 2–13. doi:10.16582/j.cnki.dzzw.2020.05.001

Woods, N. D., and Bowman, A. O. 'M. (2018). Collective action and the evolution of intergovernmental cooperation. *Policy Stud. J.* 46 (04), 487–509. doi:10.1111/psj.12241

Wu, C. (2017). *Research on public crisis governance in network environment. PhD thesis*, Central University of Finance and Economics. Available at: https://kns.cnki.net/KCMS/detail/detail.aspx?dbcode=CDFD&dbname=CDFDLAST2017&filename=1017836081.nh

Wu, C., and Zhuang, Y (2013). Collaborative governance: key variables, influencing factors and implementation approaches. *Theor. Explor.* (03), 73–77. Available at: https://kns.cnki.net/KCMS/detail/detail.aspx?dbcode=CJFQ&dbname=CJFD2013&filename=LLTS201303018

Xing, H., and Xing, L. (2021). Key factors and coupling relationships of collaborative governance for disaster prevention in China's coastal cities. *RISK Anal.* 41 (6), 895–910. doi:10.1111/risa.13586

Yang, M., and Li, Z. (2024). Research on the structure and generation path of government collaborative governance for pollution reduction and carbon reduction under the "dual carbon" target: a case study of Beijing. *J. China Univ. Geosciences Soc. Sci. Ed.* 24 (3), 73–82. doi:10.16493/j.cnki.42-1627/c.20240417.001

Yao, Y., Liu, B., Wang, S., Zu, X., and Wang, Y. (2010). Research on the influencing factors of multi-agent cooperation effect of local government network governance. *China Soft Sci.* 1, 138–149. Available at: https://kns.cnki.net/KCMS/detail/detail.aspx?dbcode=CJFQ&dbname=CJFD2010&filename=ZGRK201001016

Yaodan, Z. (2018). *Research on the collaborative governance model of community assistance in Baoding City*. Yanshan University.

Yi, H. T., Suo, L. M., Shen, R. W., Zhang, J. S., Ramaswami, A., and Feiock, R. C. (2018). Regional governance and institutional collective action for environmental sustainability. *Public Adm. Rev.* 78 (4), 556–566. doi:10.1111/puar.12799

Yong, L. (2019). *Research on the impact of government trust on political participation: analysis of the mechanism of action and change trends*. Zhejiang University.

Zhan, G., and Chen, J. (2020). Toward a pluralistic Co-governance model of environmental governance: realistic challenges and path choices. *J. Political Sci.*, 2, 65–75. Available at: https://kns.cnki.net/KCMS/detail/detail.aspx?dbcode=CJFQ&dbname=CJFDLAST2020&filename=POLI202002006

Zhang, C., Qian, Y., Huang, X., and Song, X. (2020). Research on the influencing factors of government new media response ability in public crisis information dissemination: based on the analysis of 90 public crisis events since 2013. *Mod. Intell.* 40 (7), 104–113. doi:10.3969/j.issn.1008-0821.2020.07.011

Zhang, Q., and Ai, L. (2020). The mechanism of collaborative governance to solve the poor performance of urban mineral development: from the perspective of industrial chain vulnerability. *J. Beijing Inst. Technol. Soc. Sci. Ed.* 22 (6), 20–31. doi:10.15918/j.jbitss1009-3370.2020.1145

Zhou, L. (2020). Why does vertical intervention promote local collaborative governance? -- A case study of collaborative environmental governance in the Yangtze River Delta. *Rev. Public Adm.*, 13(4), 90–107. Available at: https://kns.cnki.net/KCMS/detail/detail.aspx?dbcode=CJFQ&dbname=CJFDLAST2020&filename=GGXZ202004007