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RESEARCH ARTICLE

The environmental pathway: A scoping review on fiscal-financial synergy for sustainable county development

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ABSTRACT

A critical gap persists in the sustainability literature regarding the integrated transmission pathway from fiscal-financial policy synergy to regional development, where the environment's role as a key mediator remains under-theorized and the underlying micro-behavioral mechanisms are largely overlooked. This scoping review addresses this gap by constructing a "policy-environment-development" mediation framework, theoretically grounded in the Theory of Planned Behavior (TPB). Our analysis demonstrates that green fiscal and financial instruments enhance a region's adaptive, restorative, and transformative capacities by improving ecological quality. This environmental pathway functions by strategically shaping the behavioral intentions of key actors: influencing attitudes through incentives, forging subjective norms via market signals, and enhancing perceived behavioral control by alleviating constraints.

To enable the rigorous application and evaluation of this framework, our synthesis underscores the critical need to advance standardized environmental value accounting. Such a system is essential to robustly quantify the environment's contribution to economic development, thereby providing a universal metric for assessing policy effectiveness. The primary theoretical contribution of this study is the integration of separated research strands into a coherent model that clarifies the environmental mediation process, establishes its micro-behavioral foundations, and charts a path for its empirical validation through integrated behavioral and environmental measurement.

Keywords: Fiscal-Financial Synergy; Environmental Mediation; Theory of Planned Behavior (TPB); Sustainable County Development; Environmental Asset Valuation

1. Introduction

Sustainable development has become an essential issue in both global governance and academic research. Balanced progress needs to be achieved in the three dimensions of environment, society, and economy in order to deal with the increasingly severe ecological challenges and global inequality[1]. Although the concept of sustainability has been widely recognized, how to effectively carry it out in the primary region remains a key issue that needs to be discussed urgently.

In many countries, counties are fundamental units of national governance, and their importance in national development cannot be ignored[2]. They are not only a link between urban and rural areas, but also an important vehicle for implementing national strategies and regional coordinated development. In China,

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for example, county economies contribute 38.5% of GDP and 52% of the population—a pattern similar to that observed in other developing countries—and their industrial structure is often dominated by agriculture, industry, and tourism[3]. This specific economic profile intensifies environmental pressures through several channels: agriculture leads to nutrient runoff and water overuse; industry concentrates pollutant emissions; and tourism can degrade fragile ecosystems. These compounded pressures mean that the growing environmental constraints are not only calling for higher requirements for pollution control and resource protection but also intensifying the occurrence of extreme climate events that directly test the economic resilience of counties[4]. Economic resilience could be seen as a manifestation of the economic dimension of sustainable development. This suggests that the environment is not only a dimension of sustainable development—it has the capacity to influence other dimensions of sustainable development as well[5]. This indicates that the environment is not only a dimension of sustainable development, but also a core variable that restricts and shapes economic and social development. This understanding echoes the fundamental proposition of the Sustainable Development Theory, namely that development should seek a dynamic balance among the environment, economy and society[6].

Because environmental factors have such a profound impact on economic resilience, it is important to develop policies to manage environmental risks and enhance resilience. In this context, fiscal and financial policies are of primary importance for several compelling reasons. They directly address the core constraints of funding gaps and financial risks that hinder green transitions at the county level. Unlike industrial or technological policies that may set directions without providing means, or land-use planning that may lack enforcement mechanisms, fiscal and financial tools can create immediate economic incentives and disincentives, directly influencing the cost-benefit calculations of businesses and local governments. From a theoretical perspective, ecological modernization theory argues that economic development and environmental protection are not contradictory but can be mutually reinforcing through technological innovation and institutional reform[7]. Fiscal and financial policies are transforming toward a greener path, and their effectiveness in the environmental sector has been partially demonstrated. However, most of the existing studies remain at the macro level, paying more attention to the role of the country's overall finance and fiscal policies in green development[8,9], and less involve the fiscal and financial coordination mechanism at the county level. Meanwhile, the environmental assessment standards have not been unified. The existing measurement methods have problems such as inconsistencies in temporal and spatial scales, incomplete impact categories, and insufficient methodological basis[10].

Although counties are directly impacted by fiscal policy, their financial services are relatively weak. For this special background, fiscal-financial synergy may be the key to overcoming county environmental bottlenecks and improving economic resilience. Specifically, this study seeks to examine how fiscal – financial synergy can influence county-level sustainable development through environmental mediation, and whether environmental value accounting can provide a valid framework for evaluating such policy effectiveness. Therefore, it is necessary to study the role of fiscal and financial policy tools in sustainable development. Evaluating the effectiveness of these tools requires scientifically quantifying environmental factors, which becomes a focus of this review. As the key point of national policy and a nexus between urban and rural areas, counties show unique characteristics in their environmental-economic relationship. The current bottleneck in evaluating county-level sustainable development policies lies precisely in the lack of environmental value accounting. Only by establishing a framework for "environmental value asset accounting" can we accurately quantify the effectiveness of policies, breaking the bottlenecks and achieving sustainable goals in the future.

2. Materials and methods

This study followed the five-stage framework of Arksey&O'Malley (2005) and the latest JBI guidelines. We conducted a scoping review of the intersection of sustainable development, economic resilience, and the environment to systematically analyze the existing literature.

We used Scopus as the core database, and Web of Science as a supplement. These two databases are among the most comprehensive and authoritative abstract and citation databases, covering a wide range of high-quality journals in the fields of environmental science, economics, and social sciences. Our search terms were refined over three iterative rounds and included English and Chinese synonyms for "Sustainable development", "economic resilience", "Environmental factors", "Fiscal–financial coordination", and "Environmental value asset accounting". The logical operators used such as AND/OR. We limited the search to the period from 2015 to 2025 and included documents in Chinese, English, and Spanish. The search was completed on August 20, 2025, and the results were cross-verified by two researchers before being imported into Zotero for deduplication.

We used the PRISMA-ScR flowchart for screening. The process included:

a) Automatic deduplication in Zotero;

b) Initial screening of titles/abstracts(relevance);

c) Full-text review (quality assessment).

Figure 1 reports the number of documents at each stage. Based on the PRISMA flowchart, 826 records were identified from databases. After removing 20 duplicates, 806 records were screened, excluding 501. Full-text retrieval was sought for 305 reports, with 68 unavailable, leaving 237 for eligibility assessment. After excluding 146 reports (85 irrelevant, 42 unclear relationships, 19 methodological flaws), 91 studies were included in the review.

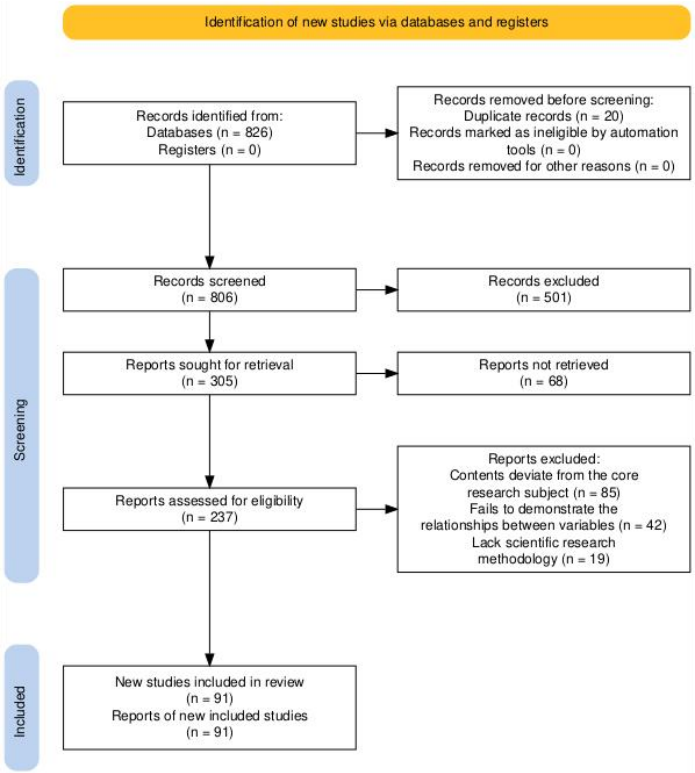

Figure 1. Overview of the screening process.

3. Research review

3.1. Economic resilience and sustainable development

Economic resilience is the foundation for sustainability. It makes economies adapt to and recover from shocks more quickly, which can protect and promote sustainable development. Without resilience, the Sustainable Development Goals(SDGs) are at risk from unexpected events[11]. Although the SDGs framework has taken resilience assessments into consideration, it still doesn't cover the infrastructural and institutional dimensions comprehensively, so supplementary indicators should be added to measure resilience better[12]. Furthermore, a cross-national panel analysis confirms that economic resilience has a significant positive impact on sustainable economic development (SED), particularly in lower-income countries. Interestingly, this effect may weaken or even turn negative in highly developed countries, suggesting that resilience policies should adapt to different development stages[13]. Overall, economic resilience is not only a buffer against crises but also a guarantee for long-term sustainable development. So it should be systematically incorporated into national development strategies and the global sustainable development agenda.

The specific mechanisms of economic resilience are categorized into four aspects: resistance, recovery, reorientation, and renewal[14]. Currently, most research focuses on industrial structure[15], human capital[16], institutions[17], policy[18], and innovation[19]. It is worth noting that there are few studies that focus on the direct relationship between the environment and economic resilience, but a large number of studies have explored the relationship between the environment and the economy.

3.2. The dual role of environmental factors in regional development

In the process of regional development, the environment exerts a dual influence, acting as both a source of constraints and a foundation for resilience. On one hand, pollution emissions, climate disasters, and resource depletion can directly undermine economic momentum and increase social vulnerability. On the other hand, ecosystems provide critical resources and services that enable regions to resist, adapt to, and recover from shocks. This section delineates this duality by examining the negative lock-in effects of environmental risks and the positive support mechanisms that underpin regional resilience, thereby establishing the "environmental mediation" through which fiscal-financial policies must operate.

3.2.1. Environmental risks and constraints

The negative effects of environmental systems manifest through a progressive chain of mechanisms—chronic erosion, sudden shock, and fundamental constraint—that collectively create a negative locking effect on a region's development path. The first link in this chain is the chronic erosion caused by pollutants, which systemically weakens development momentum through a slow, cumulative transfer of risk. This is not merely a matter of direct economic loss but a deeper degradation of production factors. For instance, air pollution creates a lasting economic drag by impairing health and productivity[20], while agricultural pollutants like microplastics and chemical fertilizers degrade soil health and contaminate water sources, thereby undermining the long-term quality of human and natural capital[21, 22]. The true nature of this harm lies in its insidious, systemic weakening of economic and ecological functions over time[23, 24].

When systemic vulnerability accumulates, extreme weather and climate disasters constitute the second link: a sudden shock mechanism. These events act as concentrated tests of socio-ecological vulnerability, often marking a turning point in a region's development. An El Niño-induced drought can severely reduce agricultural yields and elevate poverty rates[25], while extreme rainfall events expose critical weaknesses in urban infrastructure and planning[26,27]. Crucially, these shocks disproportionately impact vulnerable

communities, amplifying pre-existing inequalities by suppressing rural incomes and impacting marginalized groups, thereby revealing and accelerating deep-seated structural imbalances in regional development[28, 29].

Underpinning both chronic erosion and sudden shocks is the third and most profound link: the fundamental constraint of resource depletion. This mechanism represents a long-term erosion of the very foundation of development, often driven by an institutional crisis. The depletion of natural resources not only lowers long-term growth potential and creates external vulnerabilities[30,31] but, more critically, triggers a collapse of essential ecosystem functions. The risk of extinction facing a third of the world's tree species, for example, threatens to disrupt global carbon, water, and nutrient cycles[32]. Similarly, over-hunting in tropical forests reduces carbon sequestration by impairing seed dispersal[33]. This functional collapse, compounded by path-dependent institutional structures that reinforce resource reliance, locks regions into an unsustainable development trajectory, creating a final development trap[34]. This negative lock-in presents a clear imperative for policy intervention: fiscal and financial tools are needed to break this vicious cycle, internalize environmental costs, and de-risk sustainable investments.

Ultimately, these three environmental risks—chronic erosion, sudden shock, and fundamental constraint—are spatially intertwined and temporally cumulative, forming a vicious cycle where development leads to environmental damage, which in turn constrains further development.

3.2.2. Environmental support and well-being

In direct contrast to the risks, resilience theory illuminates how environmental systems also provide indispensable support for regional development. This positive role can be understood through a sequential mechanism encompassing resistance, reorientation, recovery, and renewal. The first line of defense is resistance, where ecosystem services form a natural barrier against shocks. Urban green spaces, for example, enhance resistance by sequestering CO_2, mitigating air pollution, regulating temperatures, and reducing flood risks through their regulatory functions[35-37]. These services constitute tangible, value-generating assets, whose preservation and enhancement can be targeted by fiscal subsidies and green financial products. However, the protection offered by these ecological barriers is not equitably distributed, as lower accessibility and participation often limit benefits for poorer groups, potentially weakening overall social resilience if left unaddressed[35].

When a shock exceeds the system's resistance threshold, reorientation becomes critical. This involves proactive institutional and technological adjustments to restructure the development path. Regions can improve their economic-environmental coordination through industrial upgrading and energy optimization[38], demonstrating an active process of turning constraints into opportunities. The key pathway for this lies in coordinated policy and community-level responses. While adaptive technologies may exist, the bottleneck often lies in institutional innovation and the implementation of holistic plans, as evidenced by the gap between policy rhetoric and quantifiable action in many coastal cities[39-41]. This underscores the critical need for well-designed fiscal-financial synergies that can incentivize and de-risk the necessary technological adoption and structural reorientation. Successful reorientation, often facilitated by nature-based solutions like Blue-Green Infrastructure (BGI), can transform declining areas into climate-resilient and economically vibrant spaces[42,43].

Following disruption, recovery is determined by the synergy between an ecosystem's self-healing capacity and human intervention. This multi-level synergy operates from the habitat scale, where green infrastructure improves ecosystem connectivity[44], to the investment scale, where ecological restoration drives economic growth and job creation[31,45]. The direct path of this process is the full restoration of

industrial and social functions, exemplified by the revitalization of desolate spaces through diverse green projects that create replicable "green blueprints" for future development[46, 47].

The highest level of support is renewal, which represents the environmental system's capacity to drive a profound transformation of the development model. This is achieved by deeply integrating institutional innovation with technological breakthroughs. At the institutional level, integrating ESG indicators into fiscal policy can shift the relationship between environment and economy from a trade-off to a synergy, signifying a fundamental shift in development philosophy[48]. On the technological front, green-tech breakthroughs and the strategic allocation of green finance are pivotal for transitioning urban clusters and resource-dependent regions towards low-carbon, resilient systems[49,50]. Although this renewal process can be constrained by weak delivery institutions[51], its ultimate outcome is a paradigm shift from "development first" to a "resilience-oriented, synergistic" development path.

In conclusion, the environmental system embodies a fundamental duality for regional development. As synthesized in **Table 1**, this duality manifests as two distinct spatiotemporal pathways: a negative lock-in effect through the chain of "chronic erosion → sudden shock → fundamental constraint", versus a positive spiral effect through the sequence of "immediate buffering → path adjustment → functional reconstruction → paradigm restructuring". The ultimate impact—which of these pathways prevails—is not predetermined. The decisive factor lies in governance, particularly the strategic deployment of fiscal and financial policy instruments. The clear delineation of this dual role establishes the environment not as a peripheral concern, but as the central mediation pathway. It is through this pathway that fiscal-financial synergy must be channeled to catalyze sustainable outcomes, a premise which the following sections will explore by examining specific policy tools and the critical framework of environmental value accounting.

Table 1. A Spatiotemporal Comparison of the Dual Role of the Environment in Regional Development: Pathways and Effects

Dimension	**Environmental Risks & Constraints (Forms a Negative Lock-in Effect)**	**Environmental Support & Well-being (Forms a Positive Spiral Effect)**
Short-term (Acute)	Sudden Shock: Extreme disasters expose system vulnerabilities and exacerbate social imbalances through inequality amplification mechanisms.	Resistance: Ecosystems (such as urban green spaces) provide a buffer, absorbing external shocks and forming the first line of defence against disasters.
Mid-term (Gradual)	Chronic Erosion: Pollutants systematically weaken the quality of production factors and development momentum through the risk transfer mechanism.	Reorientation & Recovery: Through industrial restructuring and ecological restoration investment, we will proactively reshape development paths and restore regional functions.
Long-term (Fundamental)	Fundamental Constraint: Resource depletion, through the path of institutional dependence, fundamentally erodes the foundation of development and locks in an unsustainable development model.	Renewal: Through institutional innovation and technological breakthroughs, we will deeply integrate the environment and the economy and drive the transformation of the development model to an environmentally synergistic paradigm.
Overall Pathway	Chronic Erosion → Sudden Shock → Fundamental Constraint	Immediate Buffering → Path Adjustment → Functional Reconstruction → Paradigm Restructuring

3.3. The policy implementation pathway of environmental governance

3.3.1. Institutional foundation: the necessity of polycentric governance

The preceding analysis has demonstrated that the environment possesses both the attributes of a "risk source" and a "support system". However, its positive effects face practical challenges, such as unequal distribution, implementation bottlenecks, and financial and technical constraints. These challenges are embodied within the analytical framework of the Theory of Planned Behavior (TPB). The cases discussed above all exhibit significant negative characteristics in at least one of the three core dimensions of behavioral attitude, subjective norm, and perceived behavioral control.

TPB, proposed by Ajzen, holds that an individual's behavioral intention is jointly influenced by three factors: attitudes toward the behavior, subjective norms, and perceived behavioral control. Attitudes reflect an individual's positive or negative evaluation of a particular behavior; subjective norm reflects the expectations and social pressures of significant others regarding that behavior; and perceived behavioral control reflects an individual's subjective judgment of the difficulty of executing the behavior[52]. This theory provides a systematic analytical framework for understanding the behavioral choices of various stakeholders in the implementation of environmental policies.

Numerous environmental governance practices have validated the applicability of the TPB analytical framework. In Bangkok's urban green space governance, low-income groups, due to limited accessibility, lack a clear understanding of its value, exhibiting negative behavioral attitudes and making it difficult to achieve environmental equity goals[35]. Climate adaptation policies in Queensland, Australia, are primarily constrained by a lack of subjective norms. The absence of significant legal constraints and cost-sharing mechanisms has led to fragmented local government adaptation actions[39]. These cases demonstrate that the absence of a single TPB dimension can limit governance effectiveness.

Even more complex situations arise within multi-agent governance chains. Ghana's agricultural extension policy, for example, vividly illustrates the complex interactions and transmission failures of the three TPB dimensions within multi-agent policy chains. At the policymaking level, policymakers exhibit positive characteristics across all three dimensions: a clear willingness to help farmers cope with climate risks through extension services (positive attitudes), a strong drive from national food security and climate adaptation strategies (positive subjective norms), and authority over policymaking and budget allocation (high perceived behavioral control). However, among the key roles in policy delivery — agricultural extension agents — positive attitudes toward helping farmers remain strong. However, their perceived behavioral control is severely constrained by structural barriers: poor transport, scarce extension materials, low staff-to-farmer ratios, and chronic funding shortages. These linked limits sharply reduce their capacity to act. Furthermore, farmers, the target group for the policy, exhibit significant negative behavioral attitudes and resistance to change[53]. This case study reveals a key issue: even if policymakers demonstrate positive characteristics in all three dimensions of TPB, governance effectiveness can still be severely limited due to a lack of multi-agent coordination. When any link in the policy chain exhibits negative or severely constrained TPB, the entire governance system suffers systemic failure. While policy intent can be smoothly transmitted from policymakers to implementers, the implementers' extremely low perceived behavioral control and the negative attitudes of the target group create a double barrier, ultimately preventing the achievement of policy objectives. This clearly demonstrates that the positive intentions of a single actor cannot overcome the negative performance of other key actors in the policy chain on the TPB dimensions. Governance effectiveness is inevitably constrained by weak coordination and cooperation among these actors.

As May[54]points out, the systemic complexity of environmental governance requires the ability to understand differentiated opportunities, constraints, and resources at multiple levels and scales. Traditional management models based on hierarchical systems and unidirectional control are ill-suited to addressing environmental issues involving multiple actors and spanning multiple scales. Dong[55] through their analysis of the evolution of China's ecological and environmental governance, further confirms the historical inevitability of the shift from "state-led, unidirectional governance" to "multidimensional governance by government, market, and society". The core of this shift lies in systematically optimizing the performance of each participant on the three dimensions of the TPB through a multi-faceted co-governance mechanism: enhancing each participant's perceived behavioral control capabilities through multi-level coordination mechanisms, fostering a positive subjective normative environment through institutionalized participation

platforms, and promoting the formation of positive behavioral attitudes through information integration and feedback mechanisms.

The path to achieving multi-faceted co-governance is reflected in four key aspects. First, multi-level governance provides institutional guarantees for cross-regional environmental action by clarifying the division of responsibilities at different levels. Zhao[56] based on an analysis of cross-border sections of the Yangtze River Basin, found that the frequency and scale of collaborative governance are essential for effective governance. This directly enhances the perceptual and behavioral control capabilities of stakeholders at all levels, enabling them to effectively carry out environmental governance activities within a clear institutional framework.

Second, multi-stakeholder participation mechanisms optimize the quality of governance decisions by integrating differentiated information and resources. Liu[57] found that perceptions of environmental pollution differ and interact with each other among five stakeholders: government, the public, the media, businesses, and scientists. A platform for multi-stakeholder governance can turn these different perceptions into a more comprehensive attitude and more legitimate subjective norms.

Third, responsibility and accountability mechanisms shape the normative awareness of each stakeholder by clarifying the boundaries of responsibilities and the constraints on power. May[54] points out that power and privilege embedded in institutions can lead to unfair outcomes. Effective accountability mechanisms can correct power imbalances, reinforcing the subjective normative pressure to fulfill environmental responsibilities while reducing ambiguity about responsibilities, thereby enhancing the accuracy of each party's judgment of its own behavioral capabilities (the perceived behavioral control dimension).

Fourth, fairness and oversight mechanisms ensure transparency and inclusiveness in the governance process, which plays a key role in improving the participation attitudes of each party. Rutting[58] points out that participatory processes often overlook key issues such as "whose perspectives are considered and who benefits from them". Regulatory uncertainty affects the confidence of decision-makers. This shows transparent supervision procedures can do two things: prevent marginalised groups from developing negative attitudes due to being excluded, and reduce policy uncertainty to stabilise the perceived behavioural control of all stakeholders[59].

These four dimensions constitute a systematic institutional arrangement. The legal, political, and administrative commonalities emphasized by Woldesenbet[60] provide a solid foundation for the coordinated optimization of the three dimensions of the TPB. Therefore, through systematic institutional arrangements, a multi-party governance system can effectively address the structural flaws of the single-party governance model in the TPB dimension, creating the necessary behavioral conditions and institutional environment for the effective implementation of environmental governance. The primary function of this framework lies not only in its own coordination role, but also in providing a stable, credible, and fair operating environment and institutional foundation for various environmental policy tools.

3.3.2. Policy instruments: behavioral intervention mechanisms of fiscal and financial tools

The way fiscal and financial tools work in environmental governance can be seen as a systemic behavioral intervention process. This intervention uses economic incentives and constraints to influence the cognitive basis of micro-level actors' decisions. This, in turn, guides their choices about environmental behavior. Based on TPB, the intervention effects of fiscal and financial instruments are primarily manifested through systematic influences on the three core antecedents of behavioral intention: behavioral attitudes, subjective norms, and perceived behavioral control. This theoretical framework has been widely validated in environmental science. It covers topics like waste management, green consumption, and energy conservation.

It provides a solid behavioral basis for policy design[61]. In addition to behavioral research at the consumer end, Xie et al.[62] conducted an empirical study on project managers of large-scale engineering projects in China, further confirming that TPB can effectively predict the environmental responsibility behaviors of micro-subjects, and found that subjective norms are the most powerful predictor among them. This provides a solid theoretical basis for using TPB as a behavioral intervention mechanism for analyzing fiscal and financial tools.

Fiscal and financial policy instruments, through differentiated pathways of action, exert targeted influences on each of the three antecedents of behavioral intention. Regarding attitudes toward the behavior, fiscal tools directly influence the utility calculation of individuals by adjusting the cost-benefit structure of specific actions. Theoretical model analysis shows that, in a market environment with green consumers, government subsidies can effectively incentivize businesses to adopt emission-reduction technologies, influencing their technology choices by altering their cost-benefit assessments[63]. Furthermore, negative incentive tools such as green taxes have been shown to be effective in combining with green innovation policies in emerging economies, effectively reducing emissions and improving ecological carrying capacity[64]. This cost-benefit restructuring process is further strengthened through information integration and feedback mechanisms, promoting the formation of more precise and sustained positive behavioral attitudes. However, fiscal incentives don't always give us satisfying results. Research in Pakistan has found that government incentives could crowd out intrinsic motivation[65], warning that incentive design must weigh target-group traits and the interplay with intrinsic motives.

As for subjective norms, financial tools use signals from the market to gradually shape a new system of behavioral norms. Green bonds require the issuer to disclose environmental information. This puts the company's environmental performance under the scrutiny of investors. As a result, it has a profound effect on corporate governance and environmental behavior[66]. Green credit policies further strengthen this mechanism, encouraging green innovation among polluting firms through bank oversight[67]. The development of digital finance has significantly promoted improvements in energy and environmental performance, particularly when combined with oversight and environmental regulation[68]. This norm-shaping process, based on market reputation and oversight mechanisms, encourages firms to proactively adopt environmentally friendly actions to maintain market legitimacy. It is necessary to be vigilant that if the multi-party governance framework that supports the above-mentioned market norms fails, the process of shaping subjective norms will be difficult to sustain. For instance, Tian et al.[69] pointed out that the "weak communication channels" and "free-rider problems" existing in corporate environmental governance would lead to "homogenization of green governance" and "decline in green performance", which essentially reflects the disintegration of effective industry norms. Similarly, the "homogenized comparison" and "rejection of development laws" discovered by Gu&Liu[70] by local governments are also a distorted norm of political achievements. It misleads the direction of enterprise resources and fails to form a truly healthy subjective norm of the market.

Perceived behavioral control, as the third key dimension, primarily involves the subjective assessment of the difficulty of executing specific behaviors. Financial instruments such as green credit, technology subsidies, and green insurance directly enhance firms' self-efficacy in implementing environmental behaviors by lowering the financing threshold for green technologies and sharing the risks of technological development. Evidence from a quasi-natural experiment on Chinese listed firms indicates that green credit significantly lowers corporate carbon emissions by spurring green innovation and reducing debt-financing costs[71]. In consumer behavior research, self-efficacy has been proven to be the best variable for predicting green purchasing intentions. This highlights the key role of perceived behavioral control[72]. On the other

hand, if policy tools are improperly designed, they will not only fail to enhance but also undermine the perceptual behavioral control of micro-subjects. The "fragmentation of policy tools" and "synergistic failure" revealed by Wang&He[73], as well as the "policy overload" risk pointed out by Dong et al.[74], will bring huge uncertainties and compliance complexity to enterprises. Make them feel that their environmental behavior is "out of control", thereby stifling their intention and ability for long-term transformation.

The key to maximizing the effectiveness of fiscal and financial tools is the cross-dimensional strengthening effect created by their synergy. This synergy is not a simple addition of policies. Instead, it is a systematic effect of positive feedback formed by mutually reinforcing different TPB dimensions. It's a dynamic process of complementarity, strengthening, and upward spiraling. The "fiscal interest subsidies + green credit" model is a classic example of this synergy. The fiscal interest subsidies improve a project's economic returns, which in turn improve its commercial viability and access to green credit. Then the demonstration effect of successful cases gradually transforms into market standards (shaping subjective norms), ultimately forming a multi-dimensional intervention cycle that transforms economic incentives into implementation capabilities and solidifies them into market norms. Based on theoretical inferences, other policy combinations, such as "environmental taxes + green insurance" or "carbon trading + technology subsidies", may also generate synergistic effects through similar cross-dimensional reinforcement mechanisms. Empirical research shows that the combined use of different environmental regulatory tools can produce nonlinear facilitation effects, driving the green transformation of industries[74]. However, we should notice that policy combinations do not inherently produce synergistic effects; negative interactions among instruments are possible, and careful design is required to avoid mutual interference[75]. For instance, the research by Liu et al.[76] indicates that in different social contexts, some policy combinations may exhibit "inefficient allocation" and "target conflict", resulting in poor overall environmental performance. The fundamental reason lies in that the "insufficient coordination of fiscal and financial policies" emphasized by Wang&He[73] will trigger systemic internal friction. A typical negative synergy mechanism is that frequently changing or inconsistent fiscal subsidies (affecting perceived behavioral control) conflict with green credit aimed at establishing a long-term market reputation (relying on stable subjective norms). The uncertainty created by the former directly undermines the credibility foundation on which the latter relies. Therefore, the realization of synergy is by no means a matter of course; it is highly dependent on refined top-level design that takes into account potential interference among tools.

The effectiveness of the behavioral intervention mechanism described above is deeply embedded in a framework of multi-stakeholder governance. It relies on the structural support provided by the institutional environment. A multi-level governance system ensures cross-regional policy coordination and provides stable institutional predictability for capital flows, which is key to maintaining the stability of perceived behavioral control. Through integrating diverse information and preferences, the multi-stakeholder participation mechanism allows policy tools to be designed more accurately to meet the needs of different groups. In this process, procedural justice and inclusive mechanisms are very important for making sure a policy has social legitimacy[77]. Supervision and accountability mechanisms maintain the credibility of the green finance market by curbing greenwashing and fiscal rent-seeking. At the same time, information transparency and the establishment of participatory processes can effectively strengthen subjective norms and enhance behavioral operability[78].

Thus, fiscal and financial instruments, as behavioral interventions, systematically reshape the environmental behavior choices of micro-level actors through their multidimensional influences on behavioral attitudes, subjective norms, and perceived behavioral control, as well as through cross-dimensional synergistic reinforcement. Ultimately, maximizing the effectiveness of this intervention

mechanism depends on the stability, precision, and credibility provided by a multi-party co-governance system. These three elements constitute a solid institutional foundation for behavioral intervention in environmental governance. Based on the framework of the Theory of Planned Behavior (TPB), **Table 2** systematically sorts out the mechanism by which various fiscal and financial tools guide the green transformation by influencing the behavioral attitudes, subjective norms and perceived behavioral control of micro-subjects. This analysis reveals that policy tools drive environmental governance not only through economic incentives but also by shaping the psychological dimensions of behavioral decisions, providing a crucial behavioral explanation for understanding the "fiscal - financial - environmental - resilience" transmission path.

Table 2. Classification of Fiscal and Financial Policy Instruments and Their Behavioral Intervention Mechanisms Based on TPB

Tool Category	Exemplars	Mechanism/Description	TPB Dimension Affected
Green Credit	Loans for corporate green projects [67, 71]	Lowers financing thresholds and supports green technology investment	Perceived Behavioral Control: Provides actionable means and enhances execution confidence.
Fiscal Subsidies	Subsidies for environmental projects, technology procurement [63]	Reduces costs and increases perceived economic benefits	Behavioral Attitude: Enhances intention for green behavior.
Environmental Tax / Carbon Tax	Emission fees[79], Carbon emission taxes[80]	Increases pollution costs and guides behavioral choices	Behavioral Attitude: Alters cost-benefit assessment.
Direct Funding	Government grants[81]	Provides initial capital support, lowering the entry barrier for green projects	Behavioral Attitude: Reduces costs and increases perceived benefits.
Public-Private Partnership (PPP)	PPP projects[62]	Joint investment by government and enterprises in green infrastructure	Subjective Norms: Shapes behavioral norms through cooperative standards and demonstration effects.
Green Insurance / Risk Sharing	Government-subsidized insurance[82]	Shares the risks of corporate green investment	Perceived Behavioral Control: Reduces risk and enhances execution confidence.

3.4. Towards sustainable outcomes: the role of policy in fostering adaptive and transformative development

Addressing environmental challenges and moving toward sustainable development requires two core capabilities in regional development: adaptation—adjusting systems to respond to actual or anticipated environmental changes—and transformation—fundamentally altering system structures to create new development paradigms. Current research often separates the two impact pathways: "fiscal and financial → environment" and "environment → sustainable development", lacking a systematic examination of the complete transmission mechanism. This makes it difficult for us to fully understand the entire process of how policies, with the environment as a mediator, ultimately drive the transformation of regional development. Effective environmental governance is the cornerstone for cultivating these two capabilities, and the core role of policies (including green fiscal and financial instruments) is to enable regional adaptive and transformative development by supporting and guiding environmental governance.

Policies enhance a region's ability to absorb and adapt to short- and medium-term environmental shocks by supporting environmental governance. This adaptive capacity is developed through two key pathways.

First, policies directly increase a region's buffer capacity by investing in pollution control and ecological restoration. Green fiscal investment in renewable energy and human capital can significantly enhance green economic performance and lay the foundation for a structural green transition[83]. Using

mechanisms like eco-compensation and restoration funds, the policy directly improved environmental quality. This reduced the direct impact of environmental risks on the economy and society. Cleaner water sources reduce the risk of industrial and agricultural water supply disruptions and protect the health of human capital. Improved ecosystems can better handle natural disasters. This reduces how much extreme weather events impact the regional economy. This increased buffer capacity essentially lowers system vulnerability by improving environmental quality, enabling regions to absorb better and withstand external shocks. As a result, the region can better absorb and withstand external shocks.

Secondly, policies effectively optimize regional adaptation by incentivizing adaptive technologies and practices. Green financial instruments promote this process through multiple mechanisms. Green credit not only directly supports sustainable corporate investment but also spills across regions, spreading resilience over a more expansive space[84]. Subsidies for water-saving irrigation and green credit for climate-proof infrastructure steer social resources toward sectors that can cope with the new climate. The combination of subsidies and government procurement has a complementary effect. It lowers business costs and stabilizes market demand[85]. This helps regions adjust their economic activities and lifestyles to reduce environmental pressure. The expansion of financial inclusion and digital finance supports vulnerable groups and small businesses by improving access to inclusive financial services. This further enhances the adaptive capacity of the entire system[86,87].

By guiding environmental governance, policies provide impetus for breaking through the dependence of old development paths and creating new socio-economic and technological systems. This catalytic effect on transformative development is shown in two core ways.

Strict environmental regulations and market incentives create a window of opportunity for systemic transformation. Policy tools like environmental taxes intentionally create “selective pressure” on old, high-energy, and high-pollution industries[88]. This dual mechanism breaks the existing system’s locked-in state and opens a window for fundamental change. Empirical research shows that the green effects of fiscal instruments are more pronounced in cities and regions with better governance, greater fiscal autonomy, and higher levels of digitalization[89].

Through strategic investment and institutional innovation, policies have further reshaped development paths. Large-scale tools like industrial funds and green bonds that support renewable energy and the circular economy do more than just back specific technologies. They also nurture entirely new green industrial ecosystems, supply chains, and business models. Green finance policies significantly improve corporate sustainability, with more substantial effect in high-pollution and capital-intensive industries[90]. The synergy between FinTech and green technologies can improve the efficiency of capital allocation and the diffusion of green innovation[91], driving the fundamental decoupling of the economic system from fossil fuels and shifting towards a new development paradigm characterized by extremely high resource productivity and minimal environmental impact. Green finance policies also show a clear cross-border spatial spillover effect[92], indicating that this path-restructuring has a systemic influence that goes beyond a single region.

In summary, policies, through the intermediary of environmental governance, play complementary roles in fostering adaptive and transformative development: adaptive policies focus on managing risks, while transformative policies aim to create opportunities. Existing green finance instruments can be clearly divided into incremental tools that improve existing technologies and radical tools that develop innovative projects to completely eliminate greenhouse gas emissions. The former corresponds to adaptive logic, and reflects a transformative mindset[93]. The interaction between green finance and fintech can improve ESG performance. Fintech itself must evolve into green tech, which shows the need to change in the system’s structure[91]. The

synergy between green fiscal and financial policies is seen as a key driver of these dual goals. The positive impact of green finance on green technology innovation and sustainable infrastructure development requires enhanced fiscal support. The triadic coupling of green finance, infrastructure, and technological innovation has been identified as a strategic roadmap for achieving the SDGs[94]. A strong regulatory framework promotes the availability of green finance, integrates environmental, social, and governance considerations, and aligns financial incentives with sustainable outcomes. This not only mitigates short-term climate risks and achieves adaptation goals, but also reshapes the financial-industry coupling structure to promote transformation[95].

However, a major limitation in both academia and practice is that these two policy goals are often separated. People are often content with just achieving adaptive results. They fail to consciously design policies to more profound transformation. Tools that are too singular and too intense may hurt economic stability. In contrast, A mix of low-intensity quotas, carbon trading, and CCUS subsidies keeps both environmental and economic targets on track[96]. Green bonds raise output more than carbon taxes, yet they may crowd out other green investments[97]. This suggests that the effectiveness of green fiscal and financial synergy depends on market integration, the institutional environment, and resource endowments (more literature on policy design principles is needed), and requires dynamic optimization through a scientific monitoring and evaluation system.

To measure and evaluate the final effectiveness of a policy, we need a comprehensive framework. This framework should go beyond traditional metrics. It must capture both adaptive efficiency and transformative breakthroughs. Although existing studies have not explicitly included the environment as a mediating variable in their analysis, the significant impact of these environmental improvement policies on sustainable development essentially reveals the key mediating role of the environment in connecting fiscal and financial policies with development goals. Whether green fiscal policy drives industrial upgrades through environmental quality improvements, or green finance boosts economic resilience via ecological investment, or both work together to change development patterns through environmental governance, it's clear that the environmental system acts as an irreplaceable bridge in the complete transmission path from fiscal and financial policies to sustainable development. And this urgently requires us to find more scientific and innovative ways to quantify the value and state of the core object that policies are trying to manage: the "environment".

Based on the dual roles of the environmental system, the synergy of fiscal and financial policies can be accordingly divided into two core paths: adaptability and transformation. **Table 3** systematically compares the essential differences between these two paths in terms of core concepts, policy tools, and mechanisms of action: The adaptive path aims to enhance the resilience of the system within the existing framework, while the transformative path focuses on reshaping the development paradigm through structural reforms. This distinction is of crucial significance for building a differentiated policy toolkit and achieving precise coupling between environmental governance and sustainable development.

Table 3. A Comparison of Adaptive vs. Transformative Development Pathways Based on Environmental Governance Objectives

Dimension	Adaptive Development Pathway	Transformative Development Pathway
Core Concept	Enhance the system's capacity to cope with environmental shocks within the existing structure.	Fundamentally alter the system structure to create a new development paradigm.
Core Objective	Reduce vulnerability, maintain stability, and manage risks.	Break path dependence, create opportunities, and achieve a paradigm shift.

Dimension	Adaptive Development Pathway	Transformative Development Pathway
Timeframe	Medium to short term.	Long term.
Role of Environmental Governance	Acts as a buffer: absorbs and withstands shocks by improving environmental quality.	Acts as a catalyst: guides system restructuring by creating new rules and windows of opportunity.
Typical Policy Tools	Fiscal Tools: Investment in pollution control, ecological compensation funds, subsidies for climate-resilient infrastructure. Financial Tools: Green credit (for efficiency improvements), adaptive agricultural insurance, inclusive finance.	Fiscal Tools: Environmental taxes, carbon taxes, industrial funds supporting disruptive green technologies. Financial Tools: Green bonds (for large-scale renewable energy projects), financial products linked to carbon markets, green technology venture capital.
Mechanism of Action	1. Enhance Buffering Capacity: Direct investment in pollution control and ecological restoration to reduce the direct economic impact of environmental risks. 2. Optimize Adaptation Process: Guide resources toward climate-adaptive technologies and practices through subsidies and credit.	1. Create Windows of Opportunity: Phase out old industries and create space for new technologies and sectors through strict regulations and market incentives. 2. Reshape Development Pathways: Foster entirely new green industrial ecosystems and business models through strategic investment and institutional innovation.
Contribution to Sustainable Development	Ensures the stability and resilience of economic and social dimensions, achieving the "maintenance" and "optimization" of sustainable development.	Promotes a fundamental decoupling of the economy-environment relationship, achieving a "qualitative change" and "leap" in sustainable development.

Table 3. (*Continued*)

3.5. Quantification of the environment

Based on the previous discussion of the environment's mediating role, scientifically quantifying environmental conditions is a key step. It helps us evaluate the effects of fiscal and financial policies and supports better policy design. Especially in economic research, the quantification of the environment should not be limited to ecological and physical indicators. It should also consider the environment's economic value and its impact on economic development.

3.5.1. Physical indicators of the environment

Scholars have systematically reviewed environmental physical indicators and their measurement methods, from resource utilization, material and energy consumption, environmental emissions to climate change and environmental footprint[98]. Therefore, this section will briefly review existing research. It will then outline the common environmental quantification indicators and their economic significance. Air quality indicators such as PM2.5, PM10, SO_2, NOx concentrations and the Air Quality Index (AQI) are continuous and can better reflect the immediate effectiveness of policies such as pollution control and traffic control[98]. Water quality indicators are often represented by Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD), and nitrogen and phosphorus concentrations, as well as water quality grades. These have a direct link to policies such as watershed management, point-source control, and agricultural non-point source reduction[98]. They can reflect the phased achievements of water quality improvement. For land and the ecological environment, commonly used measures include the forest coverage rate, wetland area, ecological restoration area, and the biodiversity index. These indicators not only show changes in the physical stock of ecological assets. They can also be linked to sustainable income and environmental assets through an environmental-economic accounting system[99]. From a comprehensive perspective, the evaluation of ecosystem service functions can quantify the quality of green spaces and the supply of their services. This helps reveal the uneven distribution of ecosystem services and their social impact[100]. On the

other hand, a comprehensive environmental output indicator like the Gross Ecosystem Product (GEP) tries to summarize multiple elements—like air, water, soil, and forests. This is used to evaluate the effectiveness of regional governance and for making comparisons across different areas[101]. Furthermore, research at the enterprise level also shows that environmental performance indicators have been introduced into target management and employee incentive systems, indicating that these physical indicators are not only observable but can also enter the closed loop of governance and incentives[102]. Overall, air, water, land and comprehensive indicators together constitute the "quantifiable, calculable and incentivizable" data basis in policy evaluation, providing necessary support for asset analysis in the economic sense. Measuring the physical indicators of the environment isn't enough, however. In economic studies, the economic value of the environment is more important.So it is necessary to assetize and calculate the value of the environment.

3.5.2. Environmental asset valuation

Internationally, the evolution of environmental asset valuation has followed a clear path. It has moved from exploring theoretical methods to establishing standardized institutional norms. Early research began with Ecosystem Service Value (ESV). It used methods like the equivalent factor approach to measure the contributions of ecosystems[103,104]. This served as an early framework for ecological projects and ecological compensation. Following this, Natural Capital Accounting (NCA) was proposed. It incorporates natural resources like water, forests, and soil into an "asset-liability" framework, emphasizing the capital nature of the environment[105,106]. Under the leadership of the United Nations, this idea was further institutionalized. It led to the System of Environmental-Economic Accounting (SEEA). In 2021, this was established as an international statistical standard. It tries to unify accounting standards by combining physical and monetary measurements to support policy-making[107,108]. At the same time, Green GDP was implemented in several countries. This approach includes environmental degradation in economic accounting, which allows environmental factors to be directly incorporated into macroeconomic evaluations[109,110]. All of these different attempts can be seen as different stages in the development of environmental asset valuation. However, their results still differ when trying to link them across countries and fields.

Driven by international frameworks and local innovation, China's exploration of environmental asset valuation is mainly reflected in three areas. First, the accounting for GEP is gradually becoming institutionalized. National and local pilot programs are continuously expanding. This makes it possible to show the overall contribution of ecosystems to human well-being[111-113]. Second, the establishment of natural resource balance sheets includes resource consumption and environmental damage in government accountability assessments, which helps promote strict constraints on environmental factors[114,115]. Third, the practice of ecological compensation mechanisms has played a role in cross-regional governance. It helps coordinate economic development and ecological protection through fund allocation and horizontal compensation[116-118]. These explorations represent a trend toward institutionalizing environmental asset valuation in China. However, the indicator systems and regional comparability are not yet fully unified.

To construct a quantifiable and operational "environment-policy-economy" analysis framework, this section systematically sorts out the key environmental dimensions and their corresponding measurement methods and policy tools. As shown in **Table 4**, this framework transforms environmental factors from abstract concepts into manageable policy assets, clarifying the complete transmission path from physical indicators to economic value and then to fiscal and financial policy intervention. This mapping relationship not only reveals the specific mechanism of the environment as a key mediating variable, but also provides a core analytical basis for subsequent demonstration of how "fiscal and financial synergy" can ultimately drive

regional sustainable development and resilience enhancement by precisely influencing these environmental dimensions.

Table 4. Quantification, Assetization of Key Environmental Dimensions and Their Linkage Mechanisms to Policy Instruments

Environmental Dimension	Physical Indicators	Economic Valuation / Assetization Methods	Policy Tools / Linkages	Mediating Mechanism
Air Quality	PM2.5, PM10, SO2, NOx, AQI	Health cost estimation, emission-related economic loss, environmental cost-benefit analysis	Emission taxes, carbon trading, green credit	Policy alters emission behavior → Improves air quality → Reduces health & productivity losses → Enhances economic resilience
Water Environment	COD, BOD, Nitrogen & Phosphorus concentration, Water quality grade	Water resource productivity value, eco-compensation amount, water use efficiency quantification	Agricultural pollution reduction subsidies, water governance funds, PPP projects	Policy investment/subsidies → Improves water quality → Reduces risks for industrial & domestic water use → Increases economic output
Land & Ecology	Forest coverage, Wetland area, Ecological restoration area, Biodiversity index	Ecosystem Service Value (ESV), Carbon sink value	Forest carbon sink projects, Ecological compensation funds	Policy investment → Increases forest/wetland area → Enhances ecosystem services → Supports sustainable industrial development
Comprehensive Ecology	GEP, SEEA indicator system	Natural capital accounting, Green GDP	Green fiscal investment, Green bonds, Technology innovation subsidies	Policy mix → Improves comprehensive ecology → Enhances systemic resilience & innovation capacity → Supports sustainable development

However, overall, environmental asset valuation still faces multiple challenges. First, various accounting frameworks, such as the SEEA and GEP, have differences in their accounting scope, pricing methods, and indicator selection. This means a unified global standard that can be seamlessly integrated has not yet been established. Second, present accounting frameworks mainly focus on the static value of ecosystem services. The role of the environment in long-term dynamic effects is not adequately quantified. This makes it difficult to monetize the environmental resilience value, making it impossible to effectively incorporate it into policy toolboxes such as project cost-benefit analysis, risk pricing of green finance, and fiscal policy priority assessment[93,97]. Third, there is a lack of systematic research on the interaction mechanism between the environment and the economy. As a result, accounting results have limited application in cross-regional policy comparisons and the evaluation of fiscal and financial policies.

Therefore, future research must focus on unifying conceptual and indicator systems. We should also deeply explore the long-term mechanisms through which the environment affects regional development. This will not only promote the standardization of the accounting system itself but also provide a crucial scientific basis for accurately assessing the environmental effects of fiscal and financial policies and their contribution to economic resilience.

4. Conclusion

4.1. Research context and theoretical evolution: The "environmental mediation" framework

Based on the systematic review in the previous text, this study ultimately distilled a "fiscal - financial - resilience" transmission framework with "environment" as the key mediating variable, as shown in **Figure 2**. This framework not only integrates the existing theoretical fragments but also constitutes the core theoretical contribution of this article. It clearly reveals that fiscal and financial tools, through intervention in behavioral attitudes, subjective norms and perceived behavioral control, ultimately systematically enhance the resistance, redirection, recovery and renewal capabilities of regional development via the intermediary path of improving environmental quality and capitalizing ecological value. This model provides a unified analytical blueprint for understanding and evaluating the synergy effects of fiscal and financial policies aimed at promoting sustainable development.

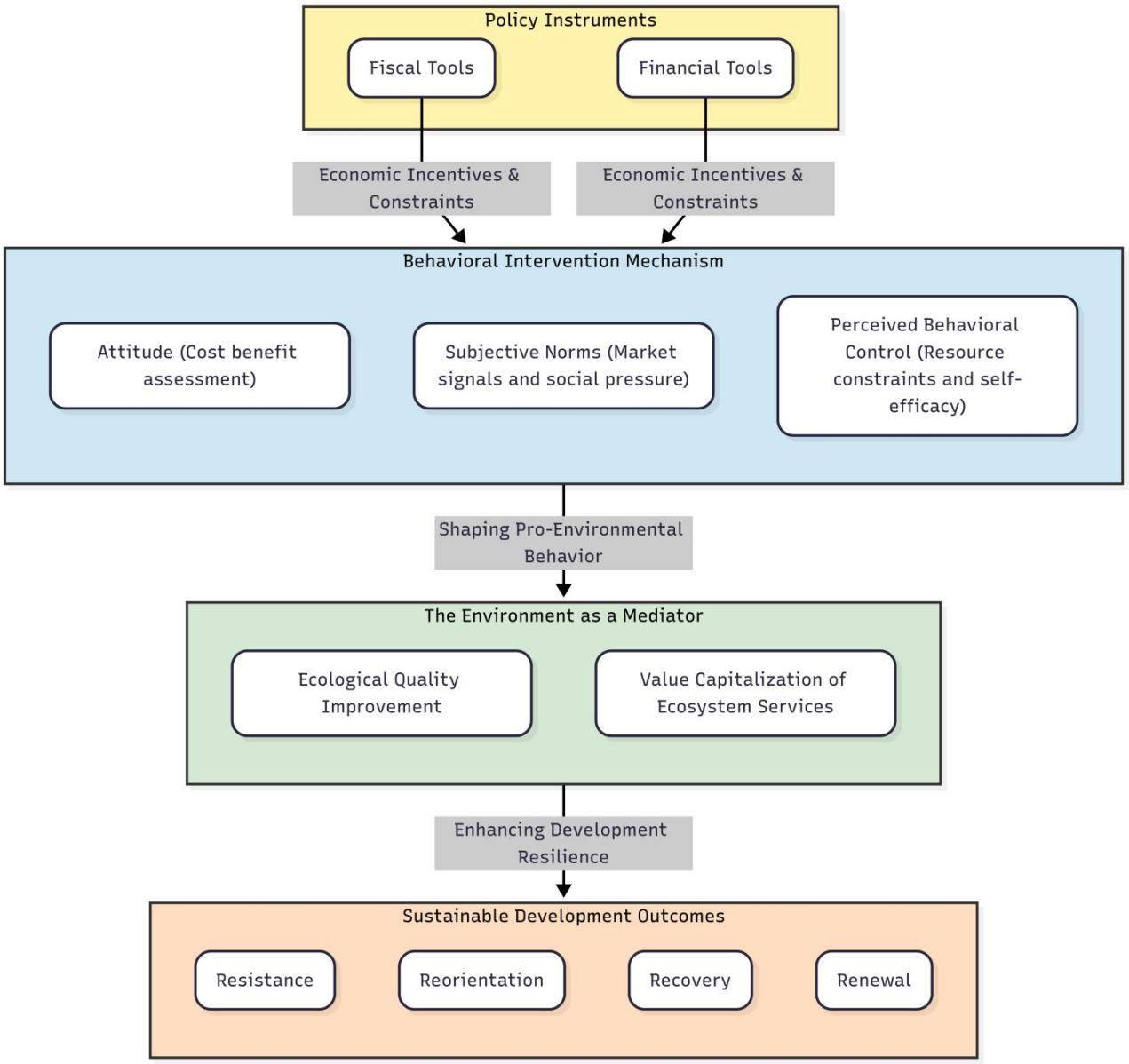

Figure 2. Theoretical Framework of Fiscal-Financial Synergy Influencing Regional Sustainable Development through Environmental Mediation

While existing research has focused on the relationship between economic resilience, environmental systems, and policy tools, significant gaps remain. A review of the relevant literature reveals that this understanding has generally progressed through three stages: from an "end-start" perspective that viewed the environment as a development condition or governance outcome, to an understanding of the environment's dual nature, and finally to attempts to integrate a more systematic theoretical framework. For instance, the Theory of Planned Behavior (TPB) has been underutilized in explaining how policies influence the intentions and actions of various stakeholders—such as governments, firms, and communities—through their effect on the environment. This study introduces a new "environmental mediation" framework to address these theoretical and practical issues, building on this evolving scholarly context.

Early research generally examined the environment outside the policy system. One strand of research interpreted the environment as the endpoint of policy implementation, namely, the environmental improvements or governance outcomes that policies aim to achieve; another strand of research viewed the environment as the starting point of development, namely, resource conditions and ecological constraints. While both emphasize the importance of the environment, in their analysis, the "policy - environment - development" chain was treated as a black box, with the environment either as an external condition or a final outcome, rather than a variable that plays a role in the transmission process. Consequently, how policies influence development through the environment and how the environment transforms its functions within it have not been fully explored. As work moves forward, the field now sees that the environment is not one-sided; it acts both as a threat and as a support. On one side, environmental decline adds cumulative, sudden and structural risks that test regional resilience. On the other side, healthy ecosystems and sound governance give the means to absorb shocks, recover growth and drive transformation. However, even at this stage, research continues to proceed along two parallel paths: one focusing on how policies can improve the environment, and the other exploring how the environment can promote development. These two paths lack an intrinsic connection, and a theoretical framework systematically explains the environment within the transmission mechanism. In other words, the role of the environment as a mediating mechanism has yet to emerge.

Based on the accumulated research, this study systematically reviews and identifies three closely related core research gaps in this field.

The first is a framework gap. Existing research often analyzes the "policy → environment" and "environment → development" pathways separately, lacking a unified and integrated mediation framework. Consequently, it is difficult to reveal the complete transmission logic of how policies influence development through the environment. This gap includes a lack of understanding of the behavioral mechanisms—such as those outlined by the TPB—through which policies ultimately influence environmental outcomes by shaping the attitudes, subjective norms, and perceived behavioral control of key actors.

The second is a methodological gap. While some studies have hinted at the potential mediating role of the environment, scientific quantitative methods are lacking to verify this. Environmental accounting often remains static, failing to capture the dynamic resilience of the environment in the intermediation process, making this process difficult to measure clearly. Similarly, methods to quantify the behavioral changes in actors as influenced by policy are underutilized.

Third, there is a gap in the application. There is currently a lack of systematic theoretical explanation and empirical support for how fiscal and financial policies can create synergies through the environment, and how environmental accounting results can be used to guide the precise design of policy instruments. Fiscal and financial instruments are often examined separately, and their potential functional complementarity and

efficiency synergy in the environmental intermediation process have not been thoroughly explored. A TPB-informed perspective suggests that synergistic policy design should aim to simultaneously positively influence the attitudes, norms, and control perceptions of target groups to achieve maximum behavioral change, a logic that requires further application.

Driven by these gaps, this study proposes that "environment" is a key mediating variable connecting policy and development. Rather than viewing the environment as an external condition or a mere outcome, it is better to view it as a "transformer" that plays a role in the transmission process. In particular, the recent rise of environmental value assetization accounting methods has made it possible to measure and validate the flow and stock changes of the environment in the intermediation process. Concurrently, behavioral frameworks like TPB provide the tools to unpack the micro-foundations of how policies translate into action by affecting human decision-making. This methodological advancement allows the quantification and evaluation of the mediating role of the environment, providing the necessary support for this study's theoretical framework. In summary, the evolution of this research context, from a fragmented perspective to a dualistic understanding and then to the proposal of a mediation framework, not only reveals the deepening of academic understanding but also highlights the room for innovation in this research. This article is motivated by addressing these underresolved issues: theoretically, it constructs a mediation framework that integrates "policy, environment, and development"; and incorporates behavioral theories like TPB to explain micro-level change; methodologically, it introduces environmental value capitalization and resilience measurement methods to capture the role of the environment in the transmission process; as well as methods to assess behavioral intention; and in practice, it clarifies the inherent logic of fiscal and financial policy coordination from a behavioral perspective and explores practical pathways for enhancing regional development resilience through environmental mediation.

4.2. Main findings and theoretical contributions

This study uses a systematic review to show that "environment" stands in the middle, linking policy to regional sustainable development, finds that the environment is not an external condition or static outcome as traditional research suggests, but rather a key transmission channel and converter through which policy instruments influence development effectiveness. Our analysis, informed by the TPB framework, further reveals that fiscal and financial policies achieve this mediation by systematically shaping the behavioral intentions of key actors — influencing their attitudes toward environmental action, reinforcing supportive subjective norms, and enhancing their perceived control over performing such actions. This finding provides a new perspective for understanding sustainable development and leads to the following three theoretical contributions.

First, this study constructs an integrated "policy-environment-development" mediation theoretical framework, resolving a long-standing theoretical divide. Most studies treat "policy → environment" and "environment → development" as separate links, thus the whole chain is broken into fragments. This framework organically integrates these two pathways, clearly positioning the environment as a key mediating variable, and reveals the complete causal chain through which policies influence regional economic resilience through changes in environmental quality and ecosystem services. By integrating behavioral mechanisms, this framework adds micro-foundations to the process. It explains how policies—which can seem abstract—are interpreted and acted upon by individuals and organizations, thus moving from the abstract "environment" variable to concrete human actions that shape it. This framework bridges academic divides and provides a systematic explanatory roadmap for analyzing the complex mechanisms of sustainable development.

Second, this study provides methodological support for this mediation framework, centered on "capitalization of environmental value" and "resilience assessment". Simply proposing a theoretical framework is insufficient to promote empirical research; the question of "how to measure" is crucial. This study argues that traditional static environmental accounting (such as the GEP) only provides a baseline state. Introducing economic resilience theory, however, allows for a dynamic measurement of the environment's mediating capacity to maintain its functions and safeguard development under pressure. Complementing this, applying the TPB framework allows for the measurement of the behavioral precursors—intentions driven by attitudes, norms, and perceived control—critical for predicting and explaining the success of environmental policies. This dynamic resilience assessment approach is a key tool for transforming environmental mediating effects from a "black box" into observable and quantifiable data, significantly enhancing the scientific validity and feasibility of subsequent empirical testing.

Third, starting from a mediation framework, this study reveals the underlying logic behind the synergy between fiscal and financial policies and their implications for policy design. This framework explains that fiscal and financial instruments require synergy because they jointly act on the mediating variable of "environment". For example, fiscal subsidies provide the initial impetus for ecological restoration, while green credit provides ongoing financing for market-based operations. From a TPB perspective, this synergy can be designed to comprehensively address the determinants of behavior: subsidies can improve the cost-benefit attitude toward green action, credit can enhance perceived behavioral control by reducing capital constraints, and both can contribute to shaping new market norms. Through their complementary functions, the two enhance the effectiveness of environmental mediation. This shifts policy design from "black box" operations to "evidence-based, precise regulation". Environmental accounting results can be directly used to optimize ecological compensation standards, green asset pricing, and other factors, thereby transforming the theoretical framework into practical, operational solutions.

4.3. Research limitations and future directions

Although the "policy – environment – development" path offered here gives a new, orderly view of sustainable development, the limits of our method and data leave several built-in weaknesses. First, while this study theoretically constructs and preliminarily demonstrates the framework through a systematic review, the robustness of its causal effects and transmission mechanisms still lacks direct empirical testing based on primary data. This includes empirical validation of the proposed behavioral pathways linking policy, actor intention, and environmental outcomes. Second, the accounting of environmental value capitalization and resilience measurement is still evolving, and there are significant differences in indicator selection and measurement methods across studies, which may lead to uncertainty in this study's methodological argumentation. Finally, this paper primarily explores the relationship between the three at a macro level, with insufficient insights into micro-mechanisms. The application of the TPB framework, while proposed, requires further micro-level empirical research to unpack how policies specifically change the attitudes, norms, and control perceptions of different actors, as well as how these changes ultimately impact the environment. To some extent, this limits the framework's guiding role in specific policy design.

Given these limitations, future research should prioritize the following directions, with the most urgent task being the empirical validation of the proposed framework.

First and most critically, rigorous empirical testing must be conducted to quantify the "environmental mediation" pathway. This requires future studies to collect multi-dimensional panel data covering fiscal, financial, environmental, and development factors. The primary analytical methods should include mediation effect models and structural equation modeling (SEM), which are specifically designed to test the complex

causal chains posited by our framework. These methods are essential to formally quantify the mediating effect of "environment" between policy and development, and to examine its variability across different policy combinations and regions. To directly assess the behavioral micro-foundations, this empirical work must integrate surveys measuring TPB variables (attitude, subjective norm, perceived behavioral control, intention) into the research design.

Second, to support this empirical testing, future research must focus on developing a standardized environmental resilience accounting system. Current environmental accounting focuses primarily on static valuations, which fail to reflect the environment's dynamic resilience to shocks. It is essential to develop an indicator system that can measure resilience, recovery, and sustainable supply, and promote the establishment of internationally comparable benchmarks to provide a methodological foundation for cross-regional comparisons of mediating effects.

Third, alongside large-n statistical tests, researchers should open the "black box" at the micro level through qualitative and mixed-methods approaches. The chain from policy, through the environment, to development, ultimately affects micro-agents like firms, communities, and households. Future research should use case studies and in-depth questionnaires to explore these specific pathways. For instance, applying behavioral frameworks like the TPB can help understand how green finance changes corporate investment behavior by influencing managers' attitudes and perceived control, or how eco-compensation encourages community participation by shaping norms and attitudes.

Fourth, cross-regional comparative research is needed to test the framework's boundary conditions. Significant differences exist between regions in environmental conditions, institutional backgrounds, and development stages, which may impact the effectiveness of mediating pathways. These contextual factors are also likely to influence how policies are perceived in terms of TPB constructs. Future studies should, therefore, compare regions of different types—such as resource-based versus innovation-driven, and centralized versus decentralized—to assess the framework's generalizability.

To sum up, while this study provides a novel theoretical framework, its main value lies in offering a testable blueprint for future research. The highest priority is the rigorous empirical testing of the environmental mediation hypothesis. If scholars systematically pursue these interconnected paths—with empirical validation at the forefront, supported by methodological, micro-level, and comparative studies—the theory can evolve from a conceptual model into an evidence-based tool for shaping effective regional governance.

4.4. Conclusions and policy implications

4.4.1. Conclusions

After a careful scan and merge of the literature, we conclude: to keep development going and to help regions bounce back, "environment" must be treated as the key middle link in the policy chain, not just an outside limit or a final by-product. The proposed "policy → environment → development" mediation framework reveals the logical path by which fiscal and financial policies achieve development goals by influencing the environment. This study further concludes that the effectiveness of policies in influencing the environment is significantly mediated by their ability to change human behavior. The Theory of Planned Behavior provides a robust framework for understanding this micro-level process, wherein policies must positively influence the attitudes, subjective norms, and perceived behavioral control of target actors to translate into environmental action and outcomes successfully. This framework emphasizes not only the carrying capacity and constraints of the environment but also its functional role in transmitting and transforming policy effects.

Additionally, we point out that the environmental asset valuation and the evaluation of the environment's resilience value are the scientific bases for understanding and measuring this mediating process. Similarly, measuring changes in behavioral intentions offers a proximate indicator of policy effectiveness before environmental outcomes are fully realized. Traditional environmental accounting is often limited to recording static stocks and service values, lacking attention to the environment's dynamic capacity to adjust to shocks. Incorporating resilience into environmental accounting not only reveals the actual role of the environment in this mediation process but also provides a quantifiable basis for policy optimization. Therefore, successful development policies must invest in and manage the mediating variable of the environment to achieve higher-quality development outcomes. Policies designed with an understanding of behavioral mechanisms, such as those outlined by TPB, are more likely to be effective by precisely targeting the determinants of individual and collective action.

4.4.2. Policy implications

First, for policymakers, this study emphasizes the importance of developing a systematic approach to "promoting development through the environment". Previous policies often treated the environment as a subsidiary variable, with policy effects primarily assessed through economic growth and social well-being, lacking attention to the environmental impact of the transmission process. Furthermore, policies often neglected the behavioral pathways to change. Future policy design should not only prioritize how policies can ultimately generate benefits through environmental mediation but also consider how they shape the intentions and behaviors of key stakeholders. Policy instruments should be designed to positively influence attitudes, strengthen supportive social norms , and enhance perceived behavioral control. Future policy design should prioritize how policies can ultimately generate benefits through environmental mediation and dynamically adjust instrument allocation based on environmental accounting results.

Second, environmental accounting data can become an important basis for financial innovation for financial institutions. Traditional financial products are often evaluated based on economic benefits, often overlooking environmental factors. However, linking financial instruments to environmental resilience performance can achieve precise capital allocation. A TPB perspective suggests that financial products can also be designed to influence client behavior. For example, preferential loans for firms with strong environmental management systems not only allocate capital but also reinforce a subjective norm and enhance the firm's perceived control over green investments.

Third, regarding policy coordination, the mediation framework proposed in this study offers a new perspective on the coordination of fiscal and financial policies. Fiscal policy improves the environmental foundation through spending and incentives, while financial policy amplifies environmental effects through capital allocation. The two can successfully create a practical synergistic effect when they both work on the "environment" as a mediator. This synergy is enhanced when policies are co-designed to address the different components of behavioral intention. For instance, a subsidy (fiscal) might improve the attitude towards a green technology, while a simultaneous loan guarantee (financial) reduces the perceived risk and barriers (perceived behavioral control), together creating a stronger motivation for adoption than either instrument alone. This means policymakers should not advance fiscal or financial tools in isolation. Instead, they should coordinate both within the same mediation chain. This will help them match and optimize inputs and outputs.

Finally, from a governance practice perspective, environmental accounting results serve not only as a reference for evaluating policy effectiveness but also as an important basis for dynamic policy optimization. Behavioral monitoring can provide complementary early-warning signals and help explain the effectiveness

(or failure) of policies. For example, environmental accounting can reveal insufficient environmental carrying capacity in certain regions, prompting timely adjustments to fiscal and financial policies. Environmental resilience assessments can also identify regions that are able to maintain their service capabilities in the face of shocks, thereby receiving priority support in resource allocation. This dynamic, accounting-based policy adjustment mechanism helps to make policies more precise and forward-looking.

In summary, this paper aims to push a paradigm shift: to change the "environment" from an external constraint on development into a core mediating asset for development. It also argues for integrating behavioral science into environmental governance, recognizing that protecting and enhancing the environment ultimately requires changing human behavior. The TPB framework offers a practical toolkit for achieving this. In this new view, the environment is no longer a passive limiting factor; it becomes an active platform for policy transmission and a structural force that supports sustainable development. This shift provides a new theoretical lens for understanding the relationship between policy and development and a more straightforward path for the coordination of fiscal and financial policies. More importantly, it provides measurable and actionable tools for policy formulation and implementation, transforming "sustainable development" from an abstract goal into a quantifiable and traceable path.

By establishing the intermediary role of the environment and integrating environmental value capitalization with resilience assessment methods, and by incorporating insights from behavioral science to understand and influence the human drivers of environmental change, this research paves a scientific and systematic path towards a sustainable future. Only by truly integrating the environment into the core of the policy-development transmission mechanism and understanding the behavioral mechanisms that underpin this integration can we maintain resilience in the face of complex challenges and achieve coordinated economic, social, and ecological progress.

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Conflict of interest

The authors declare no conflict of interest.

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