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Natural resources, digital financial inclusion, and good governance nexus with sustainable development: Fuzzy optimization to econometric modeling

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Abstract

This study aims to investigate the complex interplay between natural resources, digital financial inclusion, good governance, and sustainable development outcomes, employing a hybrid methodological approach which combines fuzzy-set qualitative comparative analysis (fsQCA), necessary condition analysis (NCA), and econometric modeling. Drawing on data from 18 countries spanning 2013–2019, the study unravels the impact of these factors on sustainable development (SD) and explores the moderating role of governance. The findings reveal positive effects of digital financial inclusion, natural resources, and good governance on SD, with governance quality enhancing the relationship between digital

financial inclusion and development outcomes. However, governance does not significantly moderate the link between natural resources and sustainability, which illustrates the need for tailored governance approaches in resource-dependent contexts. Theoretical implications highlight the relevance of institutional theory in understanding the dynamic nature of development processes, while practical implications offer actionable insights to foster holistic and resilient pathways to sustainable development. Thus, the study contributes to advancing our understanding of the intricate relationships shaping SD outcomes and informs evidence-based policy interventions in this critical domain.

KEYWORDS
natural resources, digital financial inclusion, governance, sustainable development, green finance, FinTech

1 | INTRODUCTION

The worldwide demand for sustainable development (SD) stems from the pressing necessity to tackle interconnected issues such as climate change, poverty, inequality, and the depletion of natural resources. Achieving SD faces numerous hurdles, including inadequate policy frameworks, lack of political will, resource constraints, socioeconomic disparities, short-term profit-driven approaches, technological barriers, and insufficient awareness and education (Güney, 2017). These challenges underscore the complex and multifaceted nature of sustainability, requiring concerted efforts across sectors and stakeholders to foster innovation, enact effective policies, promote inclusive growth, and ensure environmental stewardship for current and future generations. In this regard, the United Nations has introduced the concept of "sustainable development goals (SDGs)" to encourage states to make their utmost efforts to achieve these goals by 2030 (Pizzi et al., 2020). Through a dedicated emphasis on SDGs and the promotion of international cooperation, various "Conference of the Parties (COP)" events have taken place. One notable example is COP28, which seeks to establish a society that is more resilient to climate change, more equitable, and sustainable for future generations (Chopra et al., 2024). Thus, this research aims to analyze the SD progress of certain nations in relation to key elements such as natural resource extraction, digital financial inclusion, good governance, green finance, and fintech.

Natural resources serve as the foundation for SD, providing essential ecosystem services, renewable energy sources, and materials for economic activities while necessitating responsible management to avoid depletion and environmental harm. Digital financial inclusion facilitates equitable economic participation by providing access to financial services, promoting entrepreneurship, and enabling efficient resource allocation, particularly in underserved communities, thereby reducing poverty and fostering economic resilience (Kamalu & Ibrahim, 2021). Good governance ensures transparent, accountable, and participatory decision-making processes, enhancing the effectiveness of policies, fostering trust between governments and citizens, and mitigating corruption and institutional weaknesses, thus creating an enabling environment for SD initiatives to flourish and address challenges effectively.

Despite the extensive research conducted in the realm of SD, several gaps persist regarding the comprehensive investigation of the impact of natural resources, digital financial inclusion, and good governance. Although many

studies have investigated different aspects of SD, such as environmental preservation, poverty reduction, and economic advancement, the complex relationship between natural resources, digital financial inclusion, and good governance has not been sufficiently explored (Lee & Yu, 2014). Previous studies frequently concentrate on these components individually, disregarding their interdependence and the potential for synergy in promoting SD outcomes (Merino-Saum et al., 2018). Thus, there is an urgent requirement for interdisciplinary research which combines these elements and explores their collective impact on reaching comprehensive sustainability goals.

Furthermore, the moderating role of good governance in shaping the relationship between natural resources, digital financial inclusion, and SD has received limited attention in the existing literature. While individual studies have investigated the influence of governance on specific aspects of SD, such as environmental policy implementation or financial regulation, there is a dearth of research exploring how governance mechanisms moderate the effects of natural resource utilization and digital financial inclusion initiatives on overall sustainability outcomes (Kamalu & Ibrahim, 2021). Comprehending the intricate relationships among governance structures, resource management practices, financial inclusion strategies, and SD indicators is crucial for guiding policy choices and creating successful interventions which utilize the potential of natural resources and digital finance while addressing governance-related difficulties and risks (Glover et al., 2014). Therefore, bridging this research gap would provide valuable insights into the complex dynamics shaping SD trajectories and contribute to the development of more nuanced and effective policy frameworks and strategies. Thus, this study aims to dissect and comprehend the intricate dynamics between natural resources, good governance, digital financial inclusion, and SD, with a particular focus on elucidating the moderating influence of good governance. This study also investigates the necessary and sufficient conditions and configurations which predict high levels of SD.

This study have several contributions to the field of SD research. First, it unravels the complex relationships between natural resources, good governance, digital financial inclusion, and SD. By systematically examining these interconnections, it enhances our understanding of how these factors interact and influence the overarching goal of sustainability. Second, it unveils the moderating role of good governance in shaping the impact of natural resources and digital financial inclusion on SD outcomes. This contribution highlights the importance of governance structures in mediating the effectiveness of sustainability interventions, providing valuable insights for policymakers and practitioners seeking to design more effective governance frameworks. Third, it unlocks causal configurations which predict high levels of SD. By identifying the necessary and sufficient conditions for achieving sustainability goals, the study offers practical guidance for stakeholders aiming to prioritize interventions and allocate resources effectively. Fourth, it employs institutional theory to interpret the relationships between natural resources, good governance, digital financial inclusion, and SD. This theoretical lens provides a robust framework for understanding the institutional dynamics which underpin sustainability efforts, enriching scholarly discourse and informing practical interventions. Lastly, the study employs hybrid methods, including fsQCA, NCA, and econometric models such as pooled OLS and 2-step GMM, to investigate the aforementioned relationships. By integrating diverse methodological approaches, the study ensures a comprehensive analysis which leverages the strengths of each method, enhancing the rigor and robustness of its findings. This methodological contribution advances the methodological toolkit available for studying complex social phenomena and sets a precedent for future interdisciplinary research in the field of SD.

2 | LITERATURE REVIEW

2.1 | Theoretical background

Institutional theory, in a general sense, explores how institutions—defined as formal and informal rules, norms, and structures—shape human behavior and societal outcomes. It posits that institutions play a fundamental role in structuring social interactions, guiding individual and collective actions, and shaping the trajectories of organizations and

societies. Institutional theory emphasizes the importance of understanding the institutional context in which actors operate, highlighting how institutions influence decision-making processes, organizational practices, and ultimately, societal development (Glover et al., 2014). When applied to SD, institutional theory offers valuable insights into the institutional arrangements and dynamics that underpin efforts to achieve sustainability goals. Institutional theory provides insight into how both formal institutions, such as laws, regulations, and governance structures, and informal institutions, such as norms, values, and cultural practices, impact sustainability outcomes (Willmott, 2011). It underscores the significance of institutional coherence, legitimacy, and adaptability in fostering SD trajectories, highlighting the need for governance systems which promote long-term environmental stewardship, social equity, and economic resilience (Lawrence & Shadnam, 2008).

Engaging natural resources, digital financial inclusion, and good governance for SD entails leveraging institutional mechanisms to address interconnected challenges and harness opportunities for positive change (Ebrahimi & Koh, 2021). Natural resources must be managed sustainably through effective regulatory frameworks, property rights regimes, and ecosystem-based approaches which balance conservation and development imperatives. Digital financial inclusion can be promoted through inclusive policies and financial infrastructure which expand access to financial services, foster entrepreneurship, and empower marginalized communities, thereby contributing to poverty reduction and economic resilience. Good governance, characterized by transparency, accountability, and citizen participation, is essential for ensuring effective decision-making, fostering trust between governments and citizens, and promoting inclusive and equitable development outcomes (Willmott, 2011). By aligning institutional incentives, norms, and practices with sustainability objectives, natural resources, digital financial inclusion, and good governance can be harnessed as catalysts for SD, driving positive social, economic, and environmental outcomes.

To address the latest theoretical advancements in digital financial inclusion and sustainable development, it is essential to integrate perspectives which underscore the transformative potential of digital technologies in enhancing financial access and fostering sustainable outcomes. Recent scholarship emphasizes the role of digital financial inclusion not only in expanding access to formal financial services but also in promoting resilience and inclusive economic growth (Anakpo et al., 2023). By leveraging digital platforms and innovative financial technologies, such as mobile banking and digital payment systems, economies can enhance efficiency, reduce transaction costs, and broaden financial inclusion among underserved populations (Anakpo et al., 2023). Furthermore, integrating digital financial services with sustainable development goals offers opportunities to address systemic challenges, such as income inequality and environmental degradation, by promoting green finance initiatives and supporting environmentally sustainable business practices (Anakpo et al., 2023). This integrated approach aligns with evolving theories which advocate for a holistic understanding of digital financial inclusion as a catalyst for achieving broader sustainability objectives, contributing to resilient economies and equitable development outcomes in the digital age.

2.2 | Empirical literature

2.2.1 | Natural resources and sustainable development

Natural resources encompass a wide array of assets found in the environment, including minerals, water, forests, biodiversity, and energy sources, which are essential for supporting human well-being and economic development. The relationship between natural resources and SD is deeply intertwined, as the sustainable management of natural resources is crucial for achieving long-term development goals while preserving ecosystems and biodiversity (Umar et al., 2020). Sustainable development relies on the responsible utilization of natural resources to support economic growth, alleviate poverty, and enhance social equity, while also ensuring environmental integrity and resilience. However, tensions arise when natural resource exploitation exceeds ecological limits or leads to environmental degradation, social inequities, and economic instability, compromising the sustainability of development trajectories. Therefore, while natural resources are fundamental to sustainable development, their utilization must be carefully

managed to avoid negative environmental and social impacts and ensure the well-being of current and future generations.

Ahmed et al. (2024) investigated how geopolitical, economic, and institutional factors impacted China's environmental management during the Russian–Ukraine conflict, showcasing the intricate balance required for sustainable resource utilization. Similarly, Chen et al. (2024) explored the dynamics of natural resources, financial development, industrialization, and energy intensity in emerging economies, emphasizing the need for robust resource policies. Gao et al. (2024) highlighted the detrimental effects of financialization and globalization on environmental degradation in BRICS countries, urging for sustainable practices. Ge et al. (2024) and Guo et al. (2024) investigated the prosperity driven by natural resources and technological advancements, respectively, in the United States and N-11 nations, underscoring the catalysts for sustainable economic growth. Imran, Alam et al. (2024) examined the role of energy utilization and natural resource abundance in the transition from resource curse to green growth, while Ullah et al. (2024) discussed the sustainable use of hydroelectric resources and their impact on financial development and economic growth.

2.2.2 | Digital financial inclusion and sustainable development

Digital financial inclusion pertains to the availability and utilization of financial services via digital platforms, including mobile phones, the Internet, and electronic payment systems. It specifically focuses on reaching and serving groups which have limited access to such services. Digital financial inclusion plays a critical role in advancing SD by fostering financial empowerment, promoting economic resilience, and reducing poverty and inequality. Access to digital financial services can enable marginalized communities to participate more fully in the formal economy, access credit and savings mechanisms, and engage in entrepreneurial activities, thus contributing to inclusive economic growth and poverty reduction (Kuada, 2019). Moreover, digital financial inclusion can enhance the efficiency and transparency of financial transactions, reduce transaction costs, and improve access to essential services such as healthcare, education, green tax, green finance, and energy, thereby enhancing social well-being and human development. However, challenges arise when digital financial inclusion initiatives fail to address barriers such as digital literacy, infrastructure limitations, regulatory constraints, and privacy and security concerns, exacerbating inequalities and leaving vulnerable populations further marginalized (Lee et al., 2023). Therefore, while digital financial inclusion holds great potential for advancing SDGs, it must be accompanied by comprehensive policies and strategies that address these challenges and ensure that its benefits are equitably distributed across society.

2.2.3 | Good governance and sustainable development

Good governance encompasses the efficient and responsible administration of public affairs and resources by governments and institutions. It is distinguished by traits like transparency, accountability, adherence to the rule of law, and active involvement (Denters et al., 2023). The relationship between good governance and SD is fundamental and mutually reinforced. Good governance practices, such as transparent decision-making, effective institutions, and inclusive policies, are essential for creating an enabling environment conducive to SD. Strong governance fosters economic growth, social cohesion, and environmental stewardship. Moreover, good governance helps build trust between governments and citizens, encourages investment and innovation, and enhances the resilience of societies to internal and external shocks, all of which are critical for achieving SDGs (Güney, 2017). However, challenges arise when governance systems are characterized by corruption, inefficiency, and lack of accountability, undermining the effectiveness of development efforts and perpetuating inequalities and injustices (Hope, 2005). Therefore, while good governance is indispensable for SD, efforts to strengthen governance mechanisms must be accompanied by

measures to address governance deficits and ensure that development benefits are equitably distributed across society (Omri & Mabrouk, 2020).

Good governance is integral to achieving sustainable development, as emphasized by Wahab et al. (2024), who analyzed the role of economic growth, trade, resources, and institutional quality in reducing greenhouse gas emissions in OECD countries. Similarly, Wang et al. (2024) provided an in-depth analysis of environmental regulations and green economic growth in G7 economies, highlighting the crucial role of good governance in enforcing environmental policies and fostering sustainable economic practices.

2.2.4 | Moderating effects of good governance

Good governance serves as a critical moderator by shaping the institutional framework and regulatory environment within which natural resource management and digital financial inclusion initiatives operate (Denters et al., 2023). By employing transparent decision-making processes, accountable institutions, and inclusive policies, good governance can reduce the adverse consequences of unsustainable resource exploitation or exclusionary financial practices, while enhancing the beneficial outcomes of sustainable resource management and inclusive financial systems (Güney, 2017; Hope, 2005). Furthermore, good governance fosters trust between governments, citizens, and private sector actors, creating an enabling environment for collaboration, innovation, and investment in sustainable development initiatives (Omri & Mabrouk, 2020). Therefore, by moderating the relationship among natural resources, digital financial inclusion, and SD, good governance plays a pivotal role in steering societies toward more inclusive, resilient, and environmentally sustainable development pathways (Denters et al., 2023).

Imran, Khan et al. (2024) examined the implications of ecological footprint and renewable energy usage on the financial stability of South Asian countries, demonstrating how effective governance can mitigate adverse environmental impacts. Furthermore, Imran et al. (2020) explored the effect of regional factor productivity on the manufacturing sector within Sino-Pak economic ties, illustrating how governance can influence the productivity and sustainability of economic relationships.

2.2.5 | Configurational effects to predict sustainable development

The consideration of configurational effects involving digital financial inclusion, green finance, natural resources, FinTech, good governance, and economic growth in predicting SD outcomes is necessary and demanded due to the complexity and interconnectedness of these factors (Anakpo et al., 2023; Denters et al., 2023). Each of these factors represents critical dimensions of SD, and their interactions can lead to diverse outcomes (Hope, 2005). For instance, digital financial inclusion can enhance economic opportunities and social inclusion, while green finance initiatives can promote environmentally sustainable investments. Similarly, effective governance mechanisms are essential for ensuring transparent decision-making and equitable resource allocation, which are integral to SD. Sustainable development could be improved with green accounting practices, retailer social responsibility practice (Islam et al., 2024), and online marketing reaching (Karim et al., 2023). By examining the configurations of these factors, the study can uncover the synergies and trade-offs among them, providing valuable insights into the pathways to achieving SDGs (Lee et al., 2023). Therefore, considering configurational effects involving these factors is not only necessary but also demanded for a comprehensive understanding of the dynamics driving SD trajectories.

Samour et al. (2024) investigated the development of the insurance market, renewable energy, and environmental quality in the UAE using bootstrap ARDL tests, highlighting the complex interplay of these elements in achieving sustainability. Samour et al. (2023) assessed the impact of the real estate market and renewable energy on environmental quality in Belgium, providing insights into the configurational effects of market dynamics on sustainability. Song et al. (2024) explored the influence of economic policy uncertainty, sustainable energy, and eco-innovation on

carbon neutrality in China, utilizing configurational analysis to demonstrate how these factors collectively contribute to SDGs. Based on the existing review of studies, we develop Figure 1 as the conceptual framework.

3 | METHODOLOGY

3.1 | Data and variables

This study relies on a quantitative approach, drawing data from 24 countries sourced from the "Global Financial Development Database (GFDD)" the "World Development Indicator (WDI)", and the "Sustainable Development Goal Indicators (SDGI)." However, due to constraints in data availability and to ensure a more focused analysis, our study narrows its scope to 18 countries for detailed examination (Table A1 in the Appendix). Through this selection process, we construct a refined panel dataset spanning the years 2013 to 2019, capturing a comprehensive snapshot of economic, financial, and developmental trends across these countries. This dataset serves as the cornerstone of our analysis, providing a robust foundation for exploring the intricate relationships between various variables and their implications for SD over time. By leveraging this rich dataset, we aim to unravel the complexities of natural resource management and its interplay with other factors, offering valuable insights into the dynamics shaping sustainability outcomes on a global scale. Table 1 shows the details of data definition, measurement, and sources.

Sustainable development (SD) is used as a dependent variable that represents the level of SD achieved by countries and is measured using the "Sustainable Development Index (SDI)." The SDI incorporates various economic, social, and environmental indicators to assess the overall sustainability performance of a country. Higher values of the SDI indicate a greater degree of progress toward SD (Denters et al., 2023; Güney, 2017).

Digital financial inclusion is the focused independent variable which measures the extent of digital financial inclusion within countries and is captured by a composite index comprising the "number of ATMs per 100,000 adults, the number of bank branches per 100,000 adults, and the outstanding deposits with commercial banks as a percentage of GDP." Higher values of DFIN signify greater accessibility and usage of digital financial services,

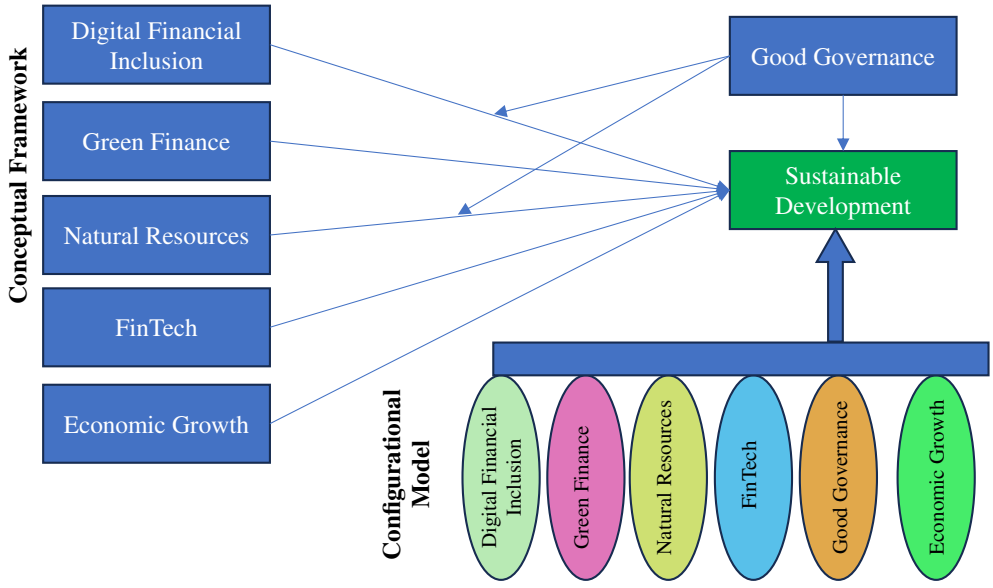

FIGURE 1 Conceptual framework and configurational model developed by authors.

TABLE 1 Data definition, measurement, and sources.

Sign	Definition	Measure	Source
SD	Sustainable development	Sustainable development index	SDGI
DFIN	Digital financial inclusion	"Financial inclusion is a composite index of ATMs (per 100,000 adults), bank branches (per 100,000 adults), and outstanding deposits with commercial banks (% of GDP)"	GFDD
NRES	Natural resources	Natural resources rents (% of GDP)	WDI
GGOV	Good Governance	Governance effectiveness rank	WDI
MDGV	Moderator of DFIN and SD	MDGV is measured by DFIN×GGOV as a moderator of digital financial inclusion and sustainable development	Author's Calculation
MRGV	Moderator of NRES and SD	MRGV is measured by NRES×GGOV as a moderator of natural resources and sustainable development	Author's Calculation
GFIN	Green Finance	Green finance development index	WDI
FinTech	FinTech lending	"Credit flows by FinTech and BigTech companies to GDP (%)"	GFDD
EGR	Economic growth	"GDP per capita (constant 2015 US$)"	WDI

indicating a higher level of financial inclusion (Kuada, 2019). Natural resource is another focused independent variable which represents the abundance of natural resources within a country and is measured as a percentage of GDP. Higher values of NRES indicate a larger share of natural resources in the country's economy.

Good governance is the final focused independent variable which assesses the quality of governance within countries and is captured by the "Governance Effectiveness Rank." This variable reflects the effectiveness of government institutions, transparency, rule of law, and regulatory quality. Lower ranks indicate stronger governance and higher levels of institutional effectiveness. Further, good governance is employed as a moderator variable. First, MDGV is a moderator of DFIN and SD which serves as a moderator of the relationship between digital financial inclusion and SD. It is calculated as the product of DFIN and GGOV, reflecting the interaction between digital financial inclusion and good governance in influencing SD outcomes. Second, MRGV is employed as another moderator of NRES and SD which acts as a moderator of the relationship between natural resources and SD. Like MDGV, it is computed as the product of NRES and GGOV, representing the interplay between natural resource abundance and good governance in shaping SD outcomes.

Finally, "green finance (GFIN), financial technology (FinTech), and economic growth (EGR)" are employed as control variables. GFIN measures the development of green finance within countries and is assessed using the "Green Finance Development Index." This variable indicates the extent to which financial systems support environmentally sustainable investments and initiatives. FinTech represents the extent of FinTech lending within countries, measured as credit flows by FinTech and BigTech companies as a percentage of GDP. Higher values of FinTech indicate greater integration of financial technology in lending activities. EGR captures the economic growth performance of countries and is measured as GDP per capita in constant 2015 US dollars.

3.2 | Analysis strategy

This research uses a hybrid methodology which combines fsQCA, NCA, and econometric models to investigate the factors affecting sustainable development (Ding, 2022). fsQCA and NCA offer qualitative insights into intricate

causal relationships and identify necessary conditions, complementing the quantitative analysis provided by econometric models (Zhang & Long, 2022). Although fsQCA and NCA offer a detailed comprehension of the arrangements and interconnections between factors like digital financial inclusion, green finance, natural resources, FinTech, economic growth, and good governance, econometric models enable precise statistical analysis, measuring the effects of these factors on SD outcomes.

The hybrid methodological approach employed in this study integrates fsQCA, NCA, and econometric modeling to comprehensively examine the multifaceted relationships between green finance, FinTech adoption, and economic growth. fsQCA and NCA are selected for their ability to uncover complex causal configurations and identify necessary and sufficient conditions within the dataset. fsQCA is particularly suited for analyzing qualitative and categorical data, allowing us to identify nuanced patterns that traditional regression methods might overlook. NCA complements this by identifying critical conditions that must be present for specific outcomes to occur, providing deeper insights into the causal mechanisms at play. These qualitative findings are then complemented and validated using econometric methods such as ordinary least squares (OLS) regression and two-stage generalized method of moments (2S-GMM). OLS regression allows us to estimate the average effects of green finance and FinTech adoption on economic growth, while 2S-GMM addresses potential endogeneity issues by instrumenting key variables and testing robustness. By employing this hybrid approach, we not only capture the complexity of causal relationships but also enhance the robustness and reliability of our findings through complementary analytical techniques. However, it is important to note that each method has its limitations; fsQCA and NCA rely heavily on data quality and case selection, while econometric methods are sensitive to model specification and assumptions. Nevertheless, by integrating these approaches, we achieve a more holistic understanding of how green finance and FinTech adoption interact to influence economic growth, thereby offering valuable insights for policymakers and stakeholders aiming to promote sustainable development.

3.2.1 | fsQCA and NCA

fsQCA, a methodological approach utilized in this study, offers a nuanced analysis of complex causal relationships among variables, particularly in the context of SD (Kraus et al., 2018). Unlike traditional econometric models, fsQCA allows for the identification of necessary and sufficient conditions for a specific outcome, accommodating nonlinear and interactive effects. This method diverges from "Multiple Regression Analysis" by exploring how combinations of conditions jointly contribute to an outcome, enabling the identification of multiple pathways to the same result (Pappas & Woodside, 2021). Furthermore, fsQCA addresses cases of equifinality and provides a more comprehensive understanding of causal mechanisms in complex systems (Ragin, 2014; Vis, 2012).

Ragin (2014) introduced the fsQCA method as a tool which bridges qualitative and quantitative research, offering an acceptable approach to understanding causal complexity. Subsequent studies by Vis (2012) and Pappas and Woodside (2021) have demonstrated the method's efficacy in identifying configurations of conditions which lead to specific outcomes, rather than relying on isolated variables. Additionally, Ragin (2014) has emphasized fsQCA's utility in policy analysis and strategic management, where it helps uncover combinations of factors that drive successful outcomes.

In the application of fsQCA, three essential steps are followed. First, data calibration is conducted by assigning maximum, average, and minimum values to transform raw data into fuzzy sets. Second, the analysis of necessary conditions diverges from NCA, where a condition is considered necessary if its consistency score exceeds 0.90, indicating its pivotal role in influencing the outcome (Dul, 2016; Ragin, 2014). Third, sufficient configuration analysis is carried out through truth table minimization, enabling the identification of combinations of conditions which jointly lead to the outcome of interest, such as natural resources. These steps collectively facilitate a comprehensive examination of complex causal relationships within the dataset, aiding in the exploration of high and low levels of SD. In

accordance with the study's methodology, Equations 1 and 2 are employed to represent high and low levels of SD, respectively.

$$\text{Sustainable Development} = f(\text{Digital Financial Inclusion, Natural Resources, Good Governance, Green Finance, FinTech, Economic Growth}) \quad (1)$$

$$\sim\text{Sustainable Development} = f(\text{Digital Financial Inclusion, Natural Resources, Good Governance, Green Finance, FinTech, Economic Growth}) \quad (2)$$

Note: $\sim$ indicates an absent or lower level of a condition.

NCA functions as a valuable complementary tool in research methodologies, serving to enhance explanatory power when used independently or in conjunction with existing techniques such as regression-based analyses or configurational analyses like fsQCA (Zhang & Long, 2022). When paired with regression-based approaches, NCA identifies essential conditions that significantly impact the outcome of interest, offering deeper insights into underlying mechanisms. Similarly, when integrated into configurational analyses like fsQCA, NCA provides precision by pinpointing necessary conditions with accuracy (Ding, 2022). NCA often reveals a greater number of necessary conditions compared with fsQCA, offering detailed insights into causal relationships and enriching the analytical process. This complementarity ensures a more comprehensive understanding of causal mechanisms and enhances the overall analytical rigor.

3.2.2 | Econometric models

Finally, this study develops the following equations as an econometric model to test the impact on sustainable development.

$$\begin{aligned} &Sustainable\ Development_{it} = \\ &\beta_0 + \beta_1 Digital\ Financial\ Inclusion_{it} + \beta_2 Natural\ Resources_{it} + \beta_3 Good\ Governance_{it} \\ &+\beta_4 Green\ Finance_{it} + \beta_5 FinTech_{it} + \beta_6 Economic\ Growth_{it} + \varepsilon, \end{aligned} \quad (3)$$

We derive the moderating effects of good governance in Equations 4 and 5. In Equation 4, the moderating role of good governance on the link between digital financial inclusion and SD is developed. Then, in Equation 5, the moderating effect of good governance on the relationship between natural resources and SD is considered.

$$\begin{aligned} &Sustainable\ Development_{it} = \\ &\beta_0 + \beta_1 Digital\ Financial\ Inclusion_{it} + \beta_2 Natural\ Resources_{it} + \beta_3 Good\ Governance_{it} \\ &+\beta_4 Green\ Finance_{it} + \beta_5 FinTech_{it} + \beta_6 Economic\ Growth_{it} + \beta_7 Digital\ Financial\ Inclision \times Good\ Governance_{it} + \varepsilon, \end{aligned} \quad (4)$$

$$\begin{aligned} &Sustainable\ Development_{it} = \\ &\beta_0 + \beta_1 Digital\ Financial\ Inclusion_{it} + \beta_2 Natural\ Resources_{it} + \beta_3 Good\ Governance_{it} \\ &+\beta_4 Green\ Finance_{it} + \beta_5 FinTech_{it} + \beta_6 Economic\ Growth_{it} + \beta_7 Natural\ Resources \times Good\ Governance_{it} + \varepsilon, \end{aligned} \quad (5)$$

where β signifies the coefficient values, with i and t denoting the country, and year, respectively. ε is the error term that encapsulates unobserved factors influencing SD, which are not explicitly captured by the model.

To address potential limitations such as endogeneity and ensure robustness in our econometric analysis, we initially employ OLS regression to estimate the relationships between green finance, FinTech, economic growth, and sustainable development outcomes. Recognizing the potential for endogeneity in our variables, we further bolster

our analysis by conducting robustness checks using the 2S-GMM approach. This method allowes us to account for endogeneity by instrumenting potentially endogenous variables with suitable instruments, ensuring our estimates are unbiased and consistent. By employing both OLS and 2S-GMM, we enhance the credibility and robustness of our findings, providing more rigorous insights into how green finance and FinTech influence economic growth and contribute to SDGs.

4 | RESULTS

4.1 | Summary statistics and correlation matrix

The descriptive statistics in Table 2 reveal key characteristics of the variables included in the dataset. The "Sustainable Development Index (SD)" exhibits a mean value of 66.07, with a standard deviation of 9.778, indicating moderate variability across countries in terms of sustainable development performance. "Digital Financial Inclusion (DFIN)" demonstrates a mean of 0.167, suggesting a relatively low level of digital financial access on average, though with considerable variation as indicated by the standard deviation of 1.54. "Natural Resources Rent (NRES)" exhibits a mean value of 3.945, with a notable standard deviation of 4.176, indicating diversity in the abundance of natural resources among the countries studied. "Good Governance (GGOV)" presents a mean of 55.332, reflecting moderate governance effectiveness across the sample countries, with a substantial standard deviation of 25.349 highlighting significant variation in governance quality. "Green Finance (GFIN)" demonstrates a mean value of 72.812, with a wide standard deviation of 59.487, indicating considerable heterogeneity in the development of environmentally sustainable financial initiatives. "Financial Technology (FinTech)" displays a mean of 0.288, reflecting limited utilization of FinTech lending on average, albeit with notable variability represented by the standard deviation of 0.734. "Economic Growth (EGR)" exhibits a mean of 14764.503, indicating moderate levels of per capita GDP across the sample countries, with substantial variability reflected in the standard deviation of 17515.944. These descriptive statistics provide a comprehensive overview of the dataset, facilitating further analysis and interpretation of the relationships between variables in the context of SD.

Within Table 2, we also present the correlation coefficients among the variables under scrutiny. Notably, all correlation values between the variables remain below 0.90, indicating the absence of multicollinearity (Rahman et al., 2023). This is crucial for upholding the reliability of subsequent regression analyses. Moreover, to delve deeper into the assessment of multicollinearity, "variance inflationary factor (VIF)" values are employed, with each value below 3.3 signaling the absence of multicollinearity concerns (Deb et al., 2022). This meticulous scrutiny ensures the solidity of the regression model, reinforcing the integrity of the study's findings.

4.2 | Results of fsQCA and NCA

To initiate the fsQCA analysis, the process commences with data calibration. This involves transforming the raw data into fuzzy sets, where the maximum value represents full membership, the average value denotes the crossover point, and the minimum value indicates full nonmembership (Olan et al., 2016; Vis, 2012). Following data calibration, the necessary condition analysis with fsQCA ensues. This stage scrutinizes whether a single condition is necessary to predict the outcome of interest. Subsequently, through truth table minimization, sufficient configurations are explored.

According to Dul (2016), a condition is deemed necessary if its consistency score exceeds 0.90. Table 3 presents the results of this analysis, revealing that no single condition, including natural resources, good governance, FinTech, digital financial inclusion, economic growth, and green finance, emerges as necessary to predict SD. This outcome suggests that no individual condition alone is sufficient to predict the outcome, underscoring the importance of

TABLE 2 Summary statistics and correlations of the investigated variables.

Variables	Mean	SD	Min	Max	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) SD	66.07	9.778	49.82	81.55	1.000						
(2) DFIN	.167	1.54	−1.517	3.505	0.703	1.000					
(3) NRES	3.945	4.176	.023	18.051	−0.786	−0.577	1.000				
(4) GGOV	55.332	25.349	9.524	96.635	0.889	0.803	−0.739	1.000			
(5) GFIN	72.812	59.487	10.247	191.364	0.703	0.856	−0.615	0.843	1.000		
(6) FinTech	.288	.734	0	4.389	0.078	−0.087	−0.159	0.084	0.250	1.000	
(7) EGR	14764.503	17515.944	554.961	60698.011	0.807	0.740	−0.603	0.853	0.779	−0.043	1.000

TABLE 3 Necessary conditions for high (low) level of sustainable development (SD).

	SD (high level)		∼SD (low level)	
Conditions	**Consistency**	**Coverage**	**Consistency**	**Coverage**
DFIN	0.710	0.901	0.334	0.412
∼DFIN	0.536	0.453	0.819	0.755
NRES	0.320	0.460	0.689	0.962
∼NRES	0.773	0.763	0.613	0.467
GGOV	0.883	0.894	0.465	0.458
∼GGOV	0.465	0.472	0.793	0.881
GFIN	0.701	0.878	0.315	0.384
∼GFIN	0.508	0.433	0.799	0.745
FinTech	0.324	0.768	0.279	0.644
∼FinTech	0.849	0.548	0.799	0.564
EGR	0.635	0.981	0.230	0.345
∼EGR	0.576	0.434	0.787	0.724

Note: ∼ indicates the absence of or a low level.
Abbreviations: DFIN, digital financial inclusion; EGR, economic growth; FinTech, financial technology; GFIN, green finance; GGOV, good governance; NRES, natural resources; SD, sustainable development.

considering combinations or configurations of conditions in elucidating the complex interplay influencing SD. Thus, these findings prompt further exploration into the synergistic effects and interactions among multiple factors to comprehensively understand the determinants of SD.

In the final stage of our analysis, we delve into the identification of sufficient configurations through truth table minimization (Ding, 2022). Model A, aimed at predicting a high level of SD, is constructed as a function of several variables: Digital Financial Inclusion (DFIN), Natural Resources (NRES), Good Governance (GGOV), Green Finance (GFIN), Financial Technology (FinTech), and Economic Growth (EGR). From this model, two configured solutions, denoted S1a and S2a, emerge as noteworthy findings (Table 4).

S1a identifies a configuration wherein a combination of higher levels of digital financial inclusion, good governance, and green finance, alongside lower levels of FinTech and economic growth, is deemed necessary and sufficient to predict a high level of SD. This configuration underscores the significance of prioritizing digital financial inclusion, effective governance, and environmentally sustainable financial initiatives while curbing the influence of excessive financial technology proliferation and managing economic growth rates.

On the other hand, S2a highlights a distinct configuration where higher levels of digital financial inclusion, natural resources, good governance, green finance, and economic growth collectively lead to a higher level of SD. This configuration emphasizes the importance of leveraging natural resources alongside other factors such as digital financial inclusion, governance effectiveness, and green finance to foster SD outcomes.

In the analysis aimed at predicting a low level of SD, Model B is formulated as a function of the studied variables (Table 5). Through this model, three distinct solutions, denoted as S1b, S2b, and S3b, emerge as significant findings.

S1b identifies a solution where the absence of digital financial inclusion, green finance, financial technology, and economic growth, as indicated by the negation (∼), contributes to a low level of SD. This configuration suggests that minimizing the influence of digital financial inclusion, green finance initiatives, financial technology proliferation, and economic growth may lead to a lower level of SD.

Similarly, S2b highlights another solution where the absence of digital financial inclusion, good governance, green finance, and economic growth is associated with a low level of SD. This configuration underscores the

TABLE 4 Sufficient configurations which lead to a high level of SD.

	Model A (high level): SD = f (DFIN, NRES, GGOV, GFIN, FinTech, EGR)	
Conditions/ Configurations	**Solution S1a: [f = (DFIN*GGOV*GFIN* ~ FinTech* ~ EGR)]**	**Solution S2a: [f = (DFIN*NRES*GGOV*GFIN*EGR)]**
DFIN	●	●
NRES	○	●
GGOV	●	●
GFIN	●	●
FinTech	⊗	○
EGR	⊗	●
Raw coverage	0.278	0.553
Unique coverage	0.013	0.325
Consistency	0.901	0.994
Solution coverage	0.837	
Solution consistency	0.900	

Note: A black circle (●) indicates the presence of the condition; a cross-circle (⊗) indicates the absence or low level of the condition; and a white circle (○) indicates the presence or absence of conditions does not matter. ~indicates the absence or a low level of a condition.
Abbreviations: DFIN, digital financial inclusion; EGR, economic growth; FinTech, financial technology; GFIN, green finance; GGOV, good governance; NRES, natural resources; SD, sustainable development.

TABLE 5 Sufficient configurations which lead to low levels of SD.

	Model B (low level): ~SD = f (DFIN, NRES, GGOV, GFIN, FinTech, EGR)		
Conditions/ Configurations	**Solution S1b: [f = (~DFIN* ~ GFIN * ~ FinTech* ~ EGR)]**	**Solution S2b: [f = (~DFIN* ~ GGOV * ~ GFIN* ~ EGR)]**	**Solution S3b: [f = (~DFIN* ~ NRES * ~ GFIN* ~ EGR)]**
DFIN	⊗	⊗	⊗
NRES	○	○	⊗
GGOV	○	⊗	○
GFIN	⊗	⊗	⊗
FinTech	⊗	○	○
EGR	⊗	⊗	⊗
Raw coverage	0.792	0.824	0.520
Unique coverage	0.025	0.046	0.000
Consistency	0.829	0.902	0.793
Solution coverage	0.937		
Solution consistency	0.826		

Note: A cross-circle (⊗) indicates the absence or low level of the condition, and a white circle (○) indicates the presence or absence of conditions does not matter. ~indicates the absence or a low level of a condition.
Abbreviations: DFIN, digital financial inclusion; EGR, economic growth; FinTech, financial technology; GFIN, green finance; GGOV, good governance; NRES, natural resources; SD, sustainable development.

importance of addressing governance deficiencies alongside other factors such as digital financial inclusion, green finance, and economic growth to mitigate the risk of low SD outcomes.

Lastly, S3b represents a solution wherein the absence of digital financial inclusion, natural resources, green finance, and economic growth contributes to a low level of SD. This configuration emphasizes the necessity of leveraging natural resources, alongside other factors like digital financial inclusion, governance effectiveness, and economic growth, to counteract the risk of low SD levels.

Now, the study initiates NCA by creating a ceiling line using XY scatter plots, as depicted in Figure A1 in the Appendix (Zhang & Long, 2022). These plots visualize the relationship between independent variables (such as digital financial inclusion, natural resources, good governance, FinTech, green finance, and economic growth) and the dependent variable (sustainable development). By visually examining the scatter plots, researchers can identify potential necessary conditions. Specifically, an empty space in the upper-left corner of the scatter plot may indicate the presence of a necessary condition. This empty space suggests that despite increasing values of the independent variable, the dependent variable remains low or absent. Such observations hint at the necessity of certain conditions for the occurrence of the outcome variable, providing valuable insights into the complex dynamics influencing SD outcomes.

Following the examination of NCA, the study proceeds to analyze the effect sizes of various conditions, as presented in Table 6. These effect sizes are measured using the d-statistic, proposed by Dul (2016), and indicate the strength of the relationship between each condition and the outcome variable. Different levels of effect sizes correspond to varying degrees of impact. According to Dul (2016), effect sizes are categorized as follows: small effect ($0 < d < 0.1$), medium effect ($0.1 \leq d \leq 0.3$), large effect ($0.3 \leq d < 0.5$), and very large effect ($d \geq 0.5$). Notably, the analysis reveals that digital financial inclusion, economic growth, and green finance exhibit medium effects, indicating a moderate impact on SD. Conversely, good governance demonstrates a large effect, suggesting a substantial influence on SD outcomes. On the other hand, FinTech displays a small effect, while natural resources exhibit a negligible impact, underscoring their limited influence on SD in comparison with other factors. These findings provide valuable insights into the relative importance of different conditions in shaping SD trajectories, aiding in the prioritization of interventions and policy measures aimed at fostering SD.

To glean insights from the necessary conditions identified in Table 7, we employ the bottleneck table, a structured representation of the ceiling lines derived from NCA. Serving as a visual aid, this table outlines the requisite levels of various conditions necessary to achieve a specific outcome, in this instance, sustainable development (Y). Each condition's levels, along with the outcome, are expressed as percentages of the observed range, with 0 denoting

TABLE 6 NCA effect sizes.

Conditions	Effect sizes (d)		Remarks
	CE-FDH	CR-FDH	
DFIN	0.203***	0.155***	Medium effect
EGR	0.173***	0.211***	Medium effect
FinTech	0.001	0.001	Small effect
GFIN	0.138***	0.163***	Medium effect
GGOV	0.383***	0.315***	Large effect
NRES	0.003***	0.003***	Small effect

Note: ***$p < .01$. Small effect: $0 < d < 0.1$, Medium effect: $0.1 \leq d \leq 0.3$, Large effect: $0.3 \leq d < 0.5$, and very large effect: $d \geq 0.5$.

Abbreviations: CE-FDH, ceiling envelopment with a free disposal hull; CR-FDH, ceiling regression with a free disposal hull; DFIN, digital financial inclusion; EGR, economic growth; FinTech, financial technology; GFIN, green finance; GGOV, good governance; NRES, natural resources.

TABLE 7 Bottleneck table (%).

Y = SD	X1 = DFIN	X2 = NRES	X3 = GGOV	X4 = GFIN	X5 = FinTech	X6 = EGR
0%	NN	NN	NN	NN	NN	NN
10%	NN	NN	NN	NN	NN	8.730
20%	5.556	NN	8.730	3.968	NN	14.286
30%	16.667	NN	22.222	12.698	NN	21.429
40%	33.333	NN	22.222	12.698	NN	38.889
50%	33.333	NN	22.222	12.698	0.794	42.063
60%	33.333	NN	22.222	12.698	0.794	43.651
70%	**34.921**	**3.968**	**31.746**	**12.698**	**4.762**	**55.556**
80%	**66.667**	**3.968**	**72.222**	**61.111**	**4.762**	**72.222**
90%	**66.667**	**3.968**	**76.984**	**61.111**	**20.635**	**81.746**
100%	**66.667**	**3.968**	**78.571**	**65.873**	**61.111**	**88.095**

Note: Bolded values indicate the minimum % to predict certain levels of natural resources. Y and X indicate the outcome and conditions, respectively.
Abbreviations: DFIN, digital financial inclusion; EGR, economic growth; FinTech, financial technology; GFIN, green finance; GGOV, good governance; NN, not Necessary; NRES, natural resources.

the minimum observed value, 100 representing the maximum observed value, and 50 indicating the midpoint (Dul, 2016). By examining this table, researchers can discern the critical thresholds of each condition which must be met to attain the desired levels of SD, facilitating targeted interventions and informed policy decisions to enhance SD efforts.

Table 7, known as the bottleneck table, presents the relationship between the levels of various conditions (X1 to X6) and the outcome variable (Y), represented as percentages. Each row in the table corresponds to a specific percentage of the outcome variable, ranging from 0% to 100%. The values in the cells denote the necessary levels of each condition required to achieve the corresponding percentage of the outcome variable. For instance, at 0% of the outcome variable (Y), denoted as the up row, all conditions (X1 to X6) are labeled as "NN," indicating that their levels are not necessary for the outcome to occur at this level. As the percentage of the outcome variable increases, specific conditions become necessary to achieve higher levels of the outcome. Looking at the table, we can observe how the levels of different conditions change as the percentage of the outcome variable increases. For example, at 50% of the outcome variable, the level of FinTech (X5) reaches 0.794%, indicating that a minimal presence of FinTech is necessary to achieve this level of the outcome. Similarly, at 80% of the outcome variable, the levels of DFIN (X1) and GGOV (X3) increase substantially, suggesting a greater necessity for digital financial inclusion and good governance to attain this level of SD.

4.3 | Econometrics results

Finally, we present the econometric results using the "ordinary least square (OLS)" model in Table 8. Table 8 shows that a positive coefficient for DFIN suggests that an increase in digital financial inclusion be associated with higher levels of SD. This aligns with the notion that improved access to financial services through digital means can enhance economic opportunities, promote financial stability, and facilitate inclusive growth, ultimately contributing to SD.

Similarly, the positive coefficient for NRES implies that greater availability and utilization of natural resources positively influence SD outcomes. Countries endowed with abundant natural resources often have opportunities for economic diversification, revenue generation, and investment in SD initiatives such as renewable energy and environmental conservation efforts. Lastly, the positive coefficient for GGOV indicates that effective governance

TABLE 8 Impact of DFIN, NRES, and GGOV on SD (Without moderation effects).

Variables	Coef.	SE	*t*-value	*p*-value	95%	CI	Sig
DFIN	1.165	.547	2.13	.03	0.082	2.248	**
NRES	.653	.122	5.35	.00	0.895	−0.411	***
GGOV	.231	.035	6.54	.00	0.161	0.302	***
GFIN	.065	.017	3.88	.00	0.099	−0.032	***
FinTech	1.487	.643	2.31	.02	0.215	2.759	**
EGR	0	0	4.22	.00	0	0	***
Constant	57.453	1.953	29.41	.00	53.585	61.321	***

Note: ***$p < .01$, **$p < .05$, *$p < .1$.
Abbreviations: DFIN, digital financial inclusion; EGR, economic growth; FinTech, financial technology; GFIN, green finance; GGOV, good governance; NRES, natural resources.

TABLE 9 Moderating effects of GGOV on the link between DFIN and SD.

Variables	Coef.	SE	*t*-value	*p*-value	95%	CI	Sig
DFIN	5.285	1.058	5.00	.00	3.19	7.38	***
NRES	.51	.118	4.32	.00	0.744	−0.276	***
GGOV	.175	.035	4.97	.00	0.106	0.245	***
DFIN × GGOV	.071	.016	4.44	.00	0.103	−0.04	***
GFIN	.06	.016	3.83	.00	0.091	−0.029	***
FinTech	1.523	.597	2.55	.01	0.34	2.705	**
EGR	0	0	6.34	.00	0	0	***
Constant	59.601	1.879	31.72	.00	55.88	63.322	***

Note: ***$p < .01$, **$p < .05$, *$p < .1$.
Abbreviations: DFIN, digital financial inclusion; EGR, economic growth; FinTech, financial technology; GFIN, green finance; GGOV, good governance; NRES, natural resources.

practices are conducive to SD. Good governance fosters political stability, rule of law, transparency, and accountability, creating an enabling environment for economic growth, social progress, and environmental sustainability.

Table 9 presents the moderation effects of "Good Governance (GGOV)" on the relationship between DFIN and SD. The results indicate positive moderation effects, suggesting that GGOV amplifies the relationship between DFIN and SD. Logically, this finding implies that the positive impact of digital financial inclusion on SD is strengthened in environments characterized by effective governance practices. Good governance enhances the effectiveness and efficiency of financial inclusion initiatives by providing a supportive regulatory framework, ensuring fair competition, protecting consumers' rights, and promoting financial stability. Additionally, transparent and accountable governance institutions instill confidence among investors, encourage entrepreneurship, and foster innovation in financial services, thereby maximizing the developmental benefits of digital financial inclusion.

The role of governance in moderating the relationship between DFIN and SD is crucial for ensuring that DFIN initiatives effectively contribute to broader development goals. Effective governance frameworks, encompassing transparency, accountability, and regulatory stability, facilitate equitable access to financial services, promote financial literacy, and attract investments in digital infrastructure. Participatory governance processes involving diverse stakeholders ensure that DFIN strategies align with local priorities, fostering inclusive economic growth and poverty reduction. Moreover, robust governance addresses challenges like data security and regulatory harmonization, enhancing the resilience and sustainability of DFIN interventions. By integrating these elements, governance plays a pivotal role in shaping how DFI can catalyze sustainable economic and social development outcomes globally.

TABLE 10 Moderating effects of GGOV on the link between NRES and SD.

Variables	Coef.	SE	*t*-value	*p*-value	95%	CI	Sig
DFIN	1.209	.549	2.20	.03	0.121	2.297	**
NRES	.496	.214	2.31	.02	0.92	−0.071	**
GGOV	.255	.044	5.78	.00	0.168	0.342	***
NRES × GGOV	.005	.006	0.90	.37	0.017	0.007	
GFIN	.068	.017	3.97	.00	0.102	−0.034	***
FinTech	1.485	.643	2.31	.02	0.211	2.758	**
EGR	0	0	2.99	.00	0	0	***
Constant	56.843	2.07	27.46	.00	52.743	60.943	***

Note: ***p < .01, **p < .05, *p < .1.
Abbreviations: DFIN, digital financial inclusion; EGR, economic growth; FinTech, financial technology; GFIN, green finance; GGOV, good governance; NRES, natural resources.

Table 10's indication that GGOV fails to amplify the relationship between NRES and SD, as demonstrated by nonsignificant moderation effects (p > .05), implies a nuanced interplay between governance quality and resource-driven development outcomes. This result suggests that effective governance may already be mitigating the adverse impacts of resource abundance, potentially through robust resource management policies or by addressing underlying factors such as the resource curse. Additionally, it underscores the complexity of governance-resource dynamics, emphasizing the need for multifaceted approaches to sustainable development which consider diverse contextual factors beyond governance quality alone.

In the context of control variables, namely Green Finance, Financial Technology and Economic Growth, the discovery of a positive and significant impact on SD across all models suggests the multifaceted nature of factors contribute to SD outcomes. The positive impact of GFIN underscores the importance of environmentally sustainable financial practices in driving long-term development initiatives, such as investments in renewable energy and conservation projects. Similarly, the positive influence of FinTech highlights the role of technological innovation in expanding financial access, promoting inclusive economic growth, and enhancing resilience to economic shocks, ultimately fostering sustainable development. Additionally, the positive relationship between EGR and SD emphasizes the critical role of sustained economic expansion in advancing social progress, poverty reduction, and environmental sustainability, highlighting the interconnectedness of economic, social, and environmental dimensions of development.

The decision to employ the Two-step generalized method of moments as a robustness check for the econometric pooled "ordinary least squares (OLS)" model in Table A2 (in the Appendix) is grounded in its suitability for addressing potential endogeneity issues and improving efficiency in parameter estimation (Lee & Yu, 2014; Windmeijer, 2008). By utilizing instrumental variables and moment conditions, the two-step GMM approach allows for consistent estimation of parameters even in the presence of endogeneity (Jin et al., 2021). Utilizing two-step GMM as a robustness check enhances the credibility of the findings by demonstrating the stability and consistency of the results across different estimation techniques. The similarity of results between the pooled OLS and two-step GMM models further validates the robustness of the findings, reinforcing confidence in the reported relationships between the independent and dependent variables.

5 | DISCUSSION

The fsQCA results unveil two distinct configurations which are deemed necessary and sufficient to predict different levels of SD, each characterized by specific combinations of factors. First, the configuration involving higher levels of

digital financial inclusion, good governance, and green finance, along with lower levels of FinTech and economic growth, suggests a nuanced approach to fostering SD. This configuration underscores the importance of balanced financial inclusion efforts, effective governance practices, and environmentally sustainable financial initiatives in driving SD outcomes. The lower emphasis on FinTech and economic growth in this configuration may imply that while technological innovation and economic expansion are beneficial, excessive reliance on them without adequate attention to governance and environmental considerations may hinder SD efforts.

Second, the configuration suggests that a comprehensive approach, encompassing diverse factors such as financial inclusion, resource abundance, effective governance, environmental sustainability, and economic growth, be essential for achieving higher levels of SD. It highlights the need for integrated policies and strategies which address multiple facets of SD simultaneously.

The NCA results reveal varying effect sizes for different factors influencing SD. Digital financial inclusion, economic growth, and green finance are identified as having medium effects, indicating their moderate but significant impact on SD outcomes. This suggests that efforts to promote financial inclusion, stimulate economic growth, and advance environmental sustainability could contribute to SD initiatives. Conversely, good governance is associated with a large effect, underscoring its pivotal role in shaping SD trajectories. Effective governance practices, such as transparency, accountability, and rule of law, are fundamental for creating an enabling environment for SD efforts. FinTech and natural resources are found to have smaller effects, implying that while they may play a role in SD, their impact is comparatively less significant than other factors. These NCA findings complement the fsQCA results by providing additional insights into the relative importance of different determinants of SD, thereby enriching our understanding of the complex interplay of factors driving sustainability outcomes.

The econometric results underscore the significant positive impacts of digital financial inclusion, natural resources, and good governance on SD, aligning with expectations based on existing literature. The findings suggest that efforts to enhance financial inclusion, effectively manage natural resources, and improve governance structures could contribute to advancing SDGs. Moreover, the identification of good governance as a moderator in strengthening the relationship between digital financial inclusion and SD further highlights the critical role of governance quality in leveraging the benefits of financial inclusion initiatives for SD outcomes. However, the lack of moderation effects for the relationship between natural resources and SD suggests that good governance might not significantly influence the direct impact of natural resources on sustainability outcomes while it is essential for overall development efforts. This discrepancy may stem from various factors, including the complex nature of resource governance, the presence of external factors influencing resource-dependent economies, or the need for more targeted governance interventions tailored to natural resource management challenges.

The study's findings, interpreted through the lens of institutional theory, offer significant theoretical implications for understanding the dynamics of SD. First, the identification of good governance as a moderator in shaping the impact of natural resources and digital financial inclusion on SD underscores the institutional mechanisms at play in sustainability efforts. Institutional theory posits that governance structures, norms, and regulations influence the behavior of actors within a system, shaping outcomes and responses to external stimuli. Hence, the results of the study indicate that well-functioning governing bodies play a vital role in either magnifying or reducing the impact of natural resource abundance and financial inclusion efforts on sustainability results. Second, the study highlights the role of institutional arrangements in configuring pathways to SD. The findings reveal how institutional environments, which include legislative frameworks, organizational norms, and stakeholder interactions, influence the establishment of sustainable development paths by identifying causal configurations which predict high sustainability levels. This aligns with institutional theory's emphasis on the importance of institutional environments in shaping behavior and outcomes within social systems. Thus, the study's theoretical implications underscore the relevance of institutional theory in elucidating the institutional dynamics which underpin sustainable development processes, offering theoretical insights that enrich scholarly discourse and inform practical interventions aimed at promoting sustainability.

The practical implications of the study's findings are significant for policymakers, practitioners, and stakeholders involved in sustainable development initiatives. First, the positive impacts identified for digital financial inclusion, natural resources, and good governance suggest clear avenues for policy intervention. Policymakers can prioritize initiatives aimed at expanding access to digital financial services, promoting sustainable management of natural resources, and enhancing governance effectiveness to drive SD outcomes. Additionally, the identification of good governance as a key moderator underscores the importance of governance reforms in maximizing the effectiveness of development interventions, particularly in leveraging the benefits of financial inclusion efforts. However, the absence of moderation effects for natural resources highlights the need for tailored governance approaches to address the unique challenges associated with resource-dependent economies.

Based on these findings, policymakers could consider implementing incentives such as tax credits or subsidies to encourage investments in green technologies and FinTech innovations. Furthermore, fostering collaboration between financial institutions, technology firms, and regulatory bodies is essential to overcome implementation barriers, such as regulatory compliance and technological adoption. By outlining actionable policy recommendations and addressing implementation challenges, our research contributes to informing policy decisions aimed at fostering sustainable economic development and achieving environmental objectives.

Policymakers should prioritize regulatory clarity and transparency to build trust in digital financial services, ensuring that regulations are conducive to fostering innovation while safeguarding consumer protection. Additionally, promoting inclusive policies which expand access to financial services, particularly among marginalized populations, can significantly contribute to reducing poverty and enhancing economic resilience. Policymakers should also consider investing in digital infrastructure and literacy programs to ensure the widespread adoption of digital financial services, thereby harnessing their potential to drive economic growth and social development. By aligning these strategies with broader sustainable development goals, policymakers can create an enabling environment which leverages DFIN as a catalyst for inclusive and sustainable development.

6 | CONCLUSIONS

This study examines the nexus of natural resources, digital financial inclusion, good governance, and SD outcomes. Leveraging a novel hybrid methodology encompassing fsQCA, NCA, and econometric modeling, our analysis has unraveled the multifaceted relationships among these variables. The findings elucidate the positive impacts of digital financial inclusion, natural resource abundance, and governance effectiveness on SD. Moreover, our investigation into the moderating role of governance has shed light on its nuanced influence, particularly in augmenting the relationship between digital financial inclusion and sustainable development outcomes. However, the nonsignificant moderation effect of governance on the link between natural resources and sustainability underscores the necessity for tailored governance approaches in resource-dependent contexts.

This study might make several contributions to the discourse on SD research. First, our rigorous analysis has deepened the understanding of the complex interactions between natural resources, digital financial inclusion, governance, and sustainability outcomes, providing valuable insights for both academia and policymaking spheres. Second, by employing a novel hybrid methodology, we have advanced methodological approaches to studying complex social phenomena, setting a precedent for interdisciplinary research in SD. Additionally, our identification of governance as a crucial moderator underscores the importance of governance quality in shaping the effectiveness of sustainability interventions, offering actionable guidance for policymakers and practitioners. Lastly, our findings contribute to theoretical advancements by highlighting the relevance of institutional theory in interpreting the institutional dynamics underlying sustainability efforts, enriching scholarly discourse in the field.

Despite the contributions of this study, several limitations warrant consideration. First, the reliance on panel data from 18 countries limits the generalizability of our findings and may overlook contextual nuances within individual countries. Additionally, while our hybrid methodology provides a comprehensive analysis, it may face challenges

in capturing the dynamic nature of SD processes over time. Furthermore, the study's focus on specific variables may omit other potentially influential factors, warranting further research for a more comprehensive understanding of sustainability dynamics. Lastly, the complexity of governance quality and its measurement may introduce subjectivity and measurement biases, necessitating careful interpretation of results.

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DATA AVAILABILITY STATEMENT

Data will be made available upon request.

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APPENDIX A

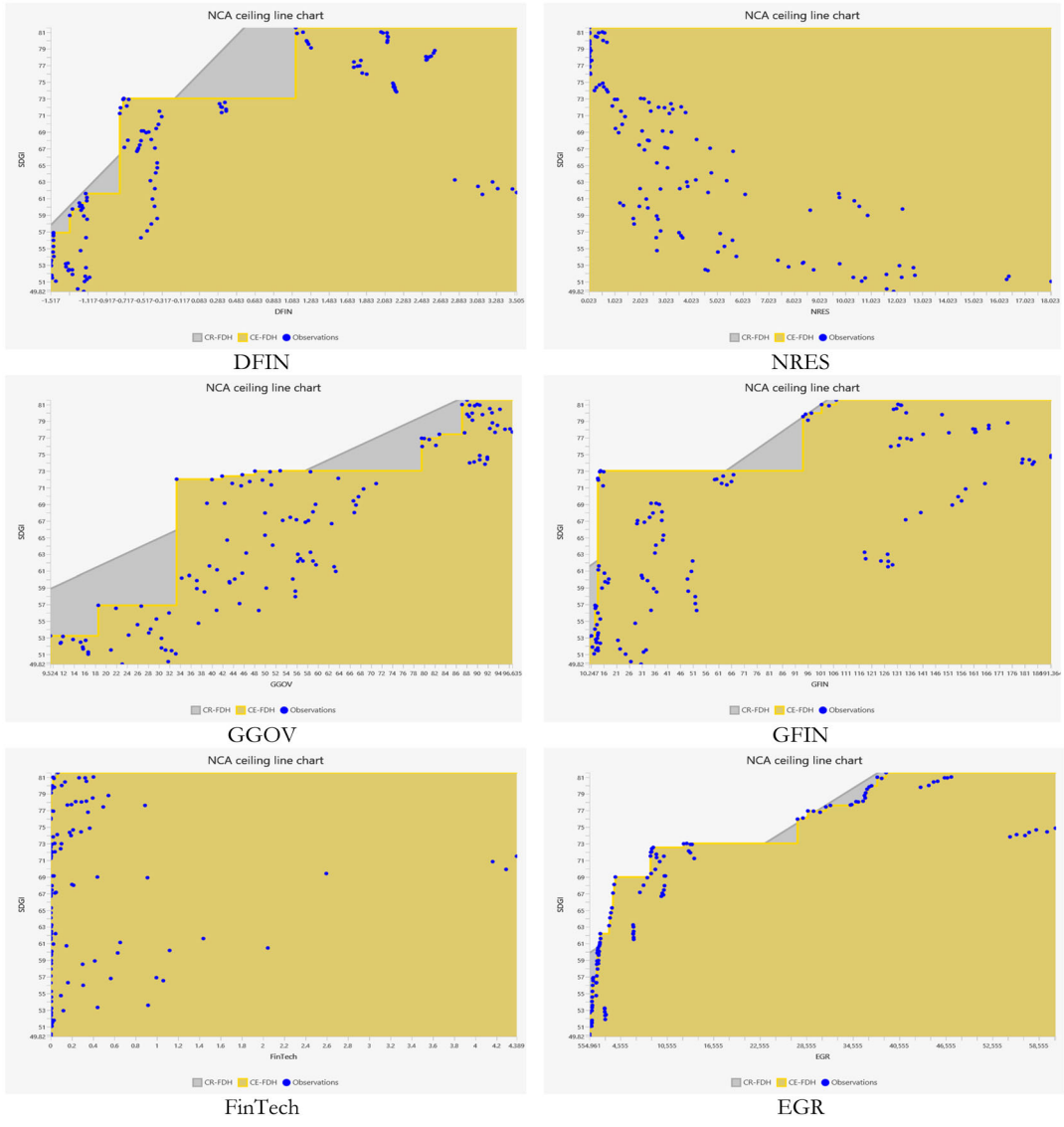

FIGURE A1 NCA ceiling line.

TABLE A1 List of sampled countries.

Argentina
Brazil
China
France
Ghana
India
Indonesia
Japan
Kenya
Korea, Rep.
Mexico
Mozambique
Nigeria
South Africa
Tanzania
Uganda
United Kingdom
United States

TABLE A2 Impact on sustainable development (two-step GMM estimation).

Variables	Model 1	Model 2	Model 3
Constant	0.820	2.119***	0.968
	[0.667]	[0.711]	[0.611]
SD (−1)	0.978***	0.961***	0.977***
	[0.010]	[0.010]	[0.009]
DFIN	0.214**	0.162	0.233**
	[0.104]	[0.158]	[0.101]
NRES	0.005	0.003	0.020
	[0.018]	[0.018]	[0.028]
GGOV	0.025***	0.022***	0.021***
	[0.004]	[0.003]	[0.004]
GFIN	0.003	0.001	0.004
	[0.003]	[0.003]	[0.003]
FinTech	0.174*	0.112	0.185**
	[0.095]	[0.096]	[0.090]
EGR	0.000***	0.000	0.000***
	[0.000]	[0.000]	[0.000]
DFIN × GGOV		**0.005*****	
		[0.001]	
NRES × GGOV			**0.000**
			[0.000]

Note: ***$p < .01$, **$p < .05$, *$p < .1$. Values in the parenthesis represent the statistics robust to heteroskedasticity and autocorrelation. Bolded variables indicate moderating variables.
Abbreviations: DFIN, digital financial inclusion; FinTech, financial technology; GFIN, green finance; GGOV, good governance; NRES, natural resources; SD, sustainable development.