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# The Dual Impact of Digital Currencies on Economy and Environment: Insights into the Role of Monetary Control

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**Abstract:** Purpose: The rapid development and adoption of digital currencies have significantly transformed the global financial environment. This study, thus, aims to examine how digital currencies (CBDC, cryptocurrency mining, and staking) affect economic performance and contribute to the green economy, with monetary control acting as an intervening mechanism. Design/Methodology/Approach: The research employs a quantitative deductive methodology, collecting data through questionnaires from 438 respondents and utilizing structural equation modelling to empirically evaluate the proposed model. The survey was administered and distributed online, enabling broad access to participants across Pakistan. Findings: The study finds that CBDC, cryptocurrency mining, and cryptocurrency staking significantly influence monetary control, which positively impacts both economic performance and the green economy. While these digital currencies directly boost economic performance, they do not directly impact the green economy. However, through monetary control, their indirect effects on both outcomes are positive and significant, indicating partial mediation for economic performance and full mediation for the green economy. Originality/Value: The research contributes to the diffusion of innovation theory in two ways. It provides a thorough analysis of how digital currencies (CBDC, cryptocurrency mining, and cryptocurrency staking) affect economic performance and the green economy, a combination that has been underexplored in prior research. It also introduces the novel concept of monetary control as a mediator, examining its influence on the relationship between digital currencies and their economic and environmental outcomes, an area not previously studied. Recommendation: Central banks should use monetary control to develop policies that optimize the economic benefits of digital currencies like CBDCs while aligning them with environmental objectives. This includes promoting CBDCs for renewable energy funding and enforcing strict environmental standards on cryptocurrency activities to balance economic growth with sustainability.

**Keywords:** Central Bank Digital Currency, Cryptocurrency, Monetary Control, Economic Performance,

Green Economy.

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## INTRODUCTION

The swift advancement and adoption of digital currencies, including central bank digital currency (CBDC), cryptocurrency mining (CRPM), and cryptocurrency staking (CRPS), have significantly transformed the global

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financial environment (Khan et al., 2020). By 2023, over 130 nations, encompassing more than 98% of the world's gross domestic product (GDP), have embarked on or are considering CBDC initiatives (Ozili, 2024). These digital representations of fiat currency, issued and governed by central banks, are designed to enhance the efficiency and security of monetary transactions while upholding the stability of traditional financial systems (Adeleye et al., 2024). CBDC aims to modernize financial operations, strengthen the efficacy of monetary policies, and provide secure alternatives to physical cash. Implementing CBDC has profound implications for economic performance (ECP), potentially driving higher GDP growth by facilitating more efficient, inclusive, and secure financial systems (Ozili, 2024).

Concurrently, the emergence of cryptocurrency mining and staking has introduced novel elements to financial markets and economic activities. Cryptocurrency mining, characterized by high energy consumption, involves solving complex computational problems to validate transactions and generate new digital coins (Anandhabalaji et al., 2024). As of 2023, Bitcoin alone has achieved a market capitalization exceeding $500 billion, reflecting its considerable impact on the global economy. The economic activities associated with cryptocurrencies contribute to GDP growth by drawing investments and creating economic value through mining and trading (Hajiaghapour-Moghimi et al., 2024). However, the environmental consequences of such mining activities, particularly the substantial energy usage of Bitcoin mining, which reportedly surpasses the annual electricity consumption of nations like Argentina or the Netherlands, highlight the need for a balanced assessment of economic benefits against environmental sustainability (Alonso et al., 2021).

This study aims to examine how these digital currencies affect economic performance and contribute to the green economy (GRE), with monetary control (MPC) acting as an intervening mechanism. The interaction between CBDC, cryptocurrency mining, and staking has the potential to influence GDP growth through impacts on financial stability and inclusion (Armas et al., 2022), while also affecting environmental sustainability. The role of effective monetary control is essential in navigating these relationships, as it optimizes the advantages of digital currencies while addressing their environmental impacts (Lee and Park, 2022). Through this analysis, the study seeks to offer an insightful understanding of how digital currencies interact with economic and environmental objectives, providing insights into their broader implications for GDP and sustainability.

As an emerging economy, Pakistan is increasingly exploring digital finance innovations, including CBDCs, which the State Bank of Pakistan (SBP) has actively researched (Khan et al., 2020). This interest in digital financial solutions makes Pakistan an ideal setting for analyzing how CBDC, cryptocurrency mining, and staking influence economic performance. Similarly, Pakistan's large informal economy and significant environmental challenges (Ghauri et al., 2024) further emphasize the relevance of this study. The introduction of CBDC has the potential to enhance financial inclusion by integrating informal economic segments into the formal financial system. Additionally, cryptocurrency mining and staking could stimulate economic activity and investment in underserved areas. However, the high energy consumption associated with mining operations poses sustainability concerns that could aggravate the country's environmental issues (Khan et al., 2020). Examining these dynamics within Pakistan's diverse economic environment, marked by varying financial infrastructure and technological adoption, offers valuable insights into the broader implications of digital finance in developing economies, informing policy and strategic decisions.

The emergence of digital currencies (CBDC, cryptocurrency mining, and staking) has significantly transformed global financial systems (Khan et al., 2020). These innovations promise to enhance financial efficiency and stimulate economic growth, yet their impacts on economic and green performance necessitate thorough examination. This study highlights the importance of evaluating how CBDC, cryptocurrency mining, and staking affect economic performance. For concern, CBDC offers the potential to streamline financial transactions and broaden financial inclusion, potentially influencing national GDP. In contrast, cryptocurrency mining, which contributes approximately $500 billion to the global economy, is notorious for its high energy consumption (Ozili, 2024). Bitcoin mining alone reportedly uses more electricity annually than entire nations like Argentina (Stefán, 2023). These statistics emphasize the urgent need to investigate the global economic impact of digital currencies.

The role of monetary policy in intervening the effects of digital currencies on economic and environmental outcomes warrants significant attention. The study highlights the necessity of understanding how monetary policy explains the relationship between digital currencies and both economic and green performance. Effective monetary policies could enhance the benefits of CBDC and cryptocurrency activities while addressing their potential drawbacks. Such as, monetary policy interventions might regulate CBDC integration to boost financial stability or tackle the environmental concerns associated with cryptocurrency mining. Given that Bitcoin's energy consumption exceeds that of some countries (Alonso et al., 2022), prudent policy measures are crucial for managing these effects.

In the context of Pakistan, these global challenges and opportunities are particularly salient. The SBP's exploration of CBDC, as of 2023, reflects a strategic move towards modernizing the country's financial sector. With Pakistan's economy characterized by a substantial informal sector, CBDC could significantly improve financial inclusion and, consequently, economic performance. Additionally, Pakistan's existing energy constraints and environmental challenges make the sustainability of cryptocurrency mining a pressing issue. By examining the impact of digital currencies on economic and green performance within Pakistan, and assessing the mediating role of monetary policy, this study aims to provide essential insights. Hence, addressing these issues is imperative for ensuring that Pakistan effectively integrates digital finance to support economic growth while achieving environmental sustainability.

Despite the growing global awareness of the need to consider the economic and environmental implications of financial and monetary policies, discussions on these issues remain surprisingly limited when it comes to CBDCs, cryptocurrency mining, and staking; topics that have increasingly captured the attention of central banks across the globe. As CBDCs expected to significantly alter the landscape of monetary policy, much of the existing research has focused on their impact on financial stability and payment systems. Only recently, within the past year, have environmental considerations linked to CBDCs started to emerge in public discussions. Key institutions like the European Central Bank (ECB) and the Bank of England (BoE) have begun to outline guidelines for the development of CBDCs, cryptocurrency mining, and staking, emphasizing the need to account for both economic and environmental impacts. Nonetheless, research specifically addressing these aspects is still in its early stages, primarily because the deployment of CBDCs and cryptocurrencies is a relatively recent development, with only a few countries having fully implemented these digital forms of currency.

As the adoption of CBDCs becomes more widespread, taming an understanding of the economic and environmental implications of digital currencies will be essential, given their potential impact on the long-term viability of economies. These effects will extend well beyond individual lives, shaping the overall stability of financial systems and the effectiveness of monetary policy tools. Since CBDCs have the capacity to function as both monetary policy instruments and payment systems, it is critical to evaluate their potential economic and environmental impacts thoroughly. Such proactive assessment is crucial to ensuring that the integration of digital currencies fosters sustainable economic development while addressing environmental concerns, particularly in regions like Pakistan, where the implications are especially significant.

This paper, thus, aims to make significant and original contributions to the debate on digital currencies by addressing crucial gaps in the existing literature. It offers a comprehensive analysis of the impact of digital currencies, specifically fiat money-CBDC, cryptocurrency mining, and cryptocurrency staking, on both economic performance and the green economy, areas that have not been sufficiently explored together in previous research. Additionally, the study examines the mediating role of monetary control in influencing the relationship between digital currencies and their economic and environmental outcomes. This mechanism has not been analyzed before. By investigating how monetary control mechanisms shape these impacts, this research provides valuable insights that could guide the formulation of policies designed to maximize the benefits of digital currencies while addressing their potential environmental and economic challenges.

## LITERATURE REVIEW

### Digital Currencies (CBDC, Mining, Staking) and Monetary Control

CBDCs represent a reflective shift in monetary control, offering central banks unparalleled ability to regulate the money supply and implement precise monetary policies (Davoodalhosseini, 2022). Unlike decentralized cryptocurrencies, which often evade regulatory oversight, CBDCs allow for real-time transaction monitoring and immediate policy adjustments (Davoodalhosseini, 2022). This enhanced control positions CBDCs as a critical tool for economic stabilization, potentially mitigating financial instability and ensuring more predictable economic outcomes (Ozili, 2023). However, the centralization inherent in CBDCs also raises concerns about surveillance and the concentration of power, which could have implications for financial privacy and autonomy (Kumhof and Noone, 2021).

*$H_{1a}$: CBDC significantly influences monetary control.*

Cryptocurrency mining, particularly in proof of work (PoW) systems like Bitcoin, fundamentally challenges traditional concepts of monetary control (Al Ahmad et al., 2018). The decentralized nature of mining networks, combined with the lack of a central regulatory authority, leads to significant volatility and unpredictability in currency values. This erosion of control complicates efforts to stabilize economies, as the value of mined cryptocurrencies fluctuate wildly based on market speculation, energy costs, and network participation (Chuen and Teo, 2021). The inability to exert monetary control over these decentralized currencies poses substantial risks to economic stability, highlighting the need for new regulatory approaches to manage their impact (Goodkind et al., 2020).

*$H_{1b}$: Cryptocurrency-mining significantly influences monetary control.*

Staking introduces a decentralized approach to monetary control, but its influence is more limited and indirect (Cong et al., 2022). By locking up assets, staking reduces liquidity and contributes to stabilizing a currency's value, creating a form of self-regulation within staking communities (Cipollini, 2024). This decentralized mechanism, however, lacks the comprehensive oversight that centralized monetary systems provide, raising questions about its effectiveness in maintaining broader economic stability (Lee and Kim, 2023). The absence of centralized intervention means that while staking may offer localized stability, it may not adequately address systemic risks that could arise from broader economic fluctuations (Cipollini, 2024).

*$H_{1c}$: Cryptocurrency-staking significantly influences monetary control.*

### Monetary Control, Economic Performance and Green Economy

Monetary control is pivotal in influencing economic performance, yet its effectiveness can be critiqued based on the varying outcomes it produces across different economic contexts. Central banks use tools like interest rate adjustments and money supply regulation to ostensibly stabilize economies (Cobham et al., 2022), but these interventions sometimes lead to unintended consequences, such as asset bubbles or market distortions (Cobham and Song, 2021). While the intention is to promote sustainable growth and reduce volatility, the centralized nature of monetary control also stifle innovation and limit the adaptability of economies to rapidly changing conditions (Rana and Al Mamun, 2024). This centralized approach, while providing short-term stability, could potentially hinder the dynamism needed for long-term economic flexibility (Cobham et al., 2022).

*$H_{2a}$: Monetary control significantly influences economic performance.*

The role of monetary control is increasingly scrutinized for its potential to either advance or impede environmental sustainability (Fu et al., 2023). While central banks have the capability to direct financial flows towards green investments, the effectiveness of these measures is often limited by broader economic priorities that may conflict with environmental goals (Dikau and Volz, 2023). For instance, the push for economic growth sometimes overshadows the need for stringent environmental regulations, leading to a compromise in green initiatives (Jothr et al., 2023). Moreover, the reliance on traditional monetary tools is not sufficient to address the complex and systemic nature of environmental challenges (Fu et al., 2023), indicating the need of monetary control in driving a genuine transition to a green economy.

*$H_{2b}$: Monetary control significantly influences green performance.*

**Digital Currencies (CBDC, Mining, Staking) and Economic Performance**

Fiat money-CBDC represent a significant advancement in digital finance, functioning as digital versions of a nation's official currency (Bank for International Settlements, 1994). Issued by central banks, CBDCs differ from decentralized cryptocurrencies due to their centralized control and status as liabilities of the central bank, maintaining parity with physical currency (Auer et al., 2020). The growing interest in CBDCs is driven by their potential to enhance payment systems, lower transaction costs, promote financial inclusion, and counter the influence of decentralized cryptocurrencies (Ozili, 2023). CBDCs is divided into two categories: retail CBDCs for general public use as digital cash, and wholesale CBDCs designed for interbank transactions and large-scale financial operations (Petare et al., 2024). Examples include China's Digital Yuan, the European Central Bank's digital Euro exploration, and the Federal Reserve's research into a digital Dollar. Researchers (Rana and Al Mamun, 2024) highlight CBDCs' centralized nature, which allows for greater control over the money supply and enhanced monetary policy implementation. However, this centralization also raises concerns about privacy, state surveillance, and the concentration of power, potentially leading to resistance from those who favor the decentralized nature of cryptocurrencies (Cobham et al., 2022). The economic benefits of CBDCs, such as reduced transaction costs and increased financial inclusion, are frequently emphasized, but often without considering potential trade-offs like technological issues, cybersecurity risks, and the public's trust (Mazambani, 2024). While CBDCs can be programmed for specific uses, such as targeted stimulus payments, this flexibility may also raise ethical and practical concerns regarding central banks' control over individual financial behavior (Davoodalhosseini, 2022). Ultimately, while CBDCs offer substantial potential benefits, their successful implementation requires careful management of technological capabilities, regulatory frameworks, and public trust (Mazambani, 2024).

*$H_{3a}$: CBDC has significant impact on economic performance.*

Cryptocurrency mining is a crucial process for generating new cryptocurrency units and verifying transactions on blockchain networks (Li et al., 2019). It primarily relies on PoW consensus mechanism, where miners use powerful computers to solve complex cryptographic puzzles. The first to solve these puzzles earns the right to add a new block to the blockchain and receives a reward in cryptocurrency (Náñez et al., 2021), such as Bitcoin. While essential for maintaining network security and integrity, the process has attracted significant scrutiny due to its high energy consumption, raising environmental concerns (Li et al., 2024). Economically, mining offers incentives for participants through newly minted cryptocurrency and transaction fees (Rosales, 2021). However, it is resource-intensive, requiring substantial investments in specialized hardware and energy, leading to economic inefficiencies and concerns about long-term sustainability (Swan, 2015). The profitability of mining is also highly volatile, dependent on the fluctuating market prices of cryptocurrencies, which introduce risks to financial systems and potentially destabilize economies heavily involved in mining activities (Li et al., 2024). The concentration of mining in regions with cheaper energy or favorable regulations exacerbates economic disparities, with wealth becoming concentrated among those who can afford the necessary resources. This trend toward centralization contradicts the decentralized ethos of cryptocurrency, raising further concerns about the future of mining as a sustainable and equitable practice (Antonopoulos, 2014).

*$H_{3b}$: Cryptocurrency-mining has significant impact on economic performance.*

Cryptocurrency staking is a significant innovation in blockchain technology, enabling participation in transaction validation and consensus within a Proof of Stake (PoS) blockchain (Gonzalez, 2022). Unlike energy-intensive mining, staking involves users validating transactions based on the number of coins they hold and stake as collateral, making it a more energy-efficient alternative (John et al., 2021). Validators earn rewards proportional to their stake, contributing to network security without the environmental impact associated with PoW. Despite its benefits, staking presents challenges. While it promotes long-term investment behavior, it also introduces risks, such as the potential loss of staked tokens due to malicious behavior or penalties imposed by the network (Lee and Kim, 2020). This raises concerns about the true economic stability offered by staking (Cong et al., 2022), as the predictability of returns is not guaranteed. Scholars argue that staking leads to more stable market conditions by encouraging users to hold cryptocurrencies longer, potentially contributing to sustained economic growth (Gudgeon et al., 2020). Additionally, staking networks often include governance mechanisms that allow stakeholders to participate in decision-making processes, which lead to more decentralized economic systems (Lee and Kim, 2020).

*$H_{3c}$: Cryptocurrency-staking has significant impact on economic performance.*

**Digital Currencies (CBDC, Mining, Staking) and Green Economy**

The transition from traditional fiat money to CBDCs presents a distinguished advancement in the pursuit of a green economy, which emphasizes sustainable development and minimal environmental impact (Lee and Park, 2022). CBDCs, issued and regulated by central banks, do not involve the energy-intensive processes that characterize cryptocurrencies like Bitcoin (Karataev et al., 2020). They operate on centralized, efficient digital platforms that can be optimized to reduce energy consumption. Auer et al. (2021) assert that CBDCs have the potential to significantly lower the carbon footprint associated with financial transactions compared to both traditional banking systems and decentralized cryptocurrencies. Additionally, by replacing physical cash (whose production and distribution also have environmental costs), CBDCs could further reduce resource use and waste. This positions CBDCs as a promising option for advancing the goals of a green economy (Kim et al., 2022), as they offer a more sustainable digital payment solution.

*$H_{4a}$: CBDC has significant impact on green performance.*

Cryptocurrency-mining, particularly within the context of PoW systems such as Bitcoin, poses considerable challenges to environmental sustainability (Erdogan et al., 2022). Mining requires solving complex cryptographic problems to validate transactions and secure the blockchain network, a process that demands extensive computational power and energy (Moura et al., 2021). The energy consumption associated with Bitcoin mining is comparable to that of entire countries, contributing significantly to carbon emissions. This energy-intensive practice not only worsens climate change but also places a strain on local resources (Erdogan et al., 2022), particularly in regions where mining activities are concentrated. Besides, many mining operations rely on non-renewable energy sources, such as coal, which further undermines their environmental sustainability (Kabundi and De Simone, 2022). The rapid obsolescence of specialized mining hardware also generates substantial electronic waste, compounding the negative environmental impact of mining (De Vries, 2023). Thus, cryptocurrency mining is largely at odds with the objectives of a green economy, which seeks to reduce carbon footprints and promote sustainable development.

*$H_{4b}$: Cryptocurrency-mining has significant impact on green performance.*

Cryptocurrency staking emerges as a more environmentally friendly alternative to mining. Unlike mining, staking is considerably less resource-intensive. Wendl et al. (2023) highlight that PoS mechanism used in staking reduces the energy demands of blockchain maintenance, making it a more sustainable practice. Staking promotes long-term investment by encouraging participants to lock up their funds for extended periods, which decreases the frequency of transactions and, in turn, lowers overall energy consumption (Wendl et al., 2023). This reduction in energy use aligns more closely with the principles of a green economy. However, it is important to note that staking still involves some level of energy consumption and does not entirely eliminate environmental concerns (De Vries, 2023). While it is less damaging than mining, the energy requirements of staking and the potential for market volatility still warrant careful consideration in the context of sustainable development.

*$H_{4c}$: Cryptocurrency-staking has significant impact on green performance.*

**Monetary Control as a Mediator between Digital Currencies and Economic Performance**

CBDCs exemplify the most robust framework for monetary control due to their centralized nature (Cobham et al., 2023). Unlike decentralized cryptocurrencies, CBDCs are governed and regulated directly by central banks, which enhances their capacity to manage the money supply, monitor transactions, and promptly address economic fluctuations (Sharif et al., 2023). This centralized control allows for effective stabilization of the economy by addressing issues such as inflation, deflation, and financial instability. Auer et al. (2020) assert that CBDCs significantly improve the effectiveness of monetary policy, leading to more predictable and stable economic conditions. The integration of CBDCs into the monetary system enables central banks to ensure that these currencies contribute positively to economic stability and growth, thereby minimizing potential disruptions (Cobham and Song, 2021).

*$H_{5a}$: Monetary control significantly mediates between CBDC and economic performance.*

Cryptocurrency mining, particularly PoW systems like Bitcoin, presents significant challenges to traditional monetary control concepts (Cipollini, 2024). Mining operates on decentralized networks that are not directly regulated by central authorities, making effective monetary control difficult (Yin et al., 2022). This absence of central control leads to high volatility and unpredictability in the value of mined cryptocurrencies, complicating efforts to stabilize economic performance (Rana and Al Mamun, 2024). Bitcoin's decentralized design intentionally excludes central monetary control, appealing to users seeking financial autonomy but also introducing risks due to the lack of regulatory oversight (Karau, 2023). This lack of control undermines the ability to intervene economic outcomes effectively (Cipollini, 2024), often resulting in increased fluctuations in economic performance.

*$H_{5b}$: Monetary control significantly mediates between cryptocurrency-mining and economic performance.*

Cryptocurrency staking represents a less direct form of monetary control. Staking involves the temporary lock-up of assets to support the network, which helps reduce liquidity and potentially stabilize the currency's value (Dikau and Volz, 2023). While this mechanism indirectly supports economic stability, it lacks the direct regulatory oversight characteristic of CBDCs. The decentralized governance model of staking communities fosters a more stable economic environment, but this stability is inherently fragmented compared to the centralized approach of CBDCs (Lee and Park, 2022). Therefore, although staking contributes to economic stability, it does not offer the same level of regulatory control necessary to fully intervene economic performance (Auer et al., 2020).

*$H_{5c}$: Monetary control significantly mediates between cryptocurrency-staking and economic performance.*

**Monetary Control as a Mediator between Digital Currencies and the Green Economy**

CBDCs benefit from efficient digital platforms that facilitate their integration into the financial system while minimizing resource use and waste associated with physical cash (Kuzma et al., 2020). Central banks harness CBDCs to implement green monetary policies, such as promoting sustainable investments and reducing the environmental footprint of traditional cash (Auer et al., 2021). The robust regulatory framework governing CBDCs enables a management approach that supports both economic stability and environmental sustainability, making them the most compatible digital currency with green economy principles.

*$H_{6a}$: Monetary control significantly mediates between CBDC and green performance.*

Cryptocurrency mining, highlights significant shortcomings in monetary control and environmental sustainability (Yang et al., 2023). Mining operations are characterized by high energy consumption and substantial carbon emissions, which starkly contradict green economy principles (Moura et al., 2021). The decentralized nature of mining networks limits the ability of central authorities to regulate or mitigate environmental impacts. This challenge is further exacerbated by the reliance on non-renewable energy sources and the generation of electronic waste (Kabundi and De Simone, 2022). The lack of effective monetary control in mining operations undermines efforts to align with green economy objectives, emphasizing the need for more regulated and sustainable approaches to digital currency management (De Vries, 2023).

*$H_{6b}$: Monetary control significantly mediates between cryptocurrency-mining and green performance.*

Cryptocurrency staking, although more energy-efficient than mining, encounters challenge due to its indirect form of monetary control. Staking mechanisms reduce liquidity and can stabilize the currency's value through decentralized governance (Dikau and Volz, 2023). This decentralized approach to monetary control relies on collective action rather than direct regulatory oversight, which contributes to a more stable economic environment. However, this indirect control is insufficient for fully embedding environmental sustainability into the framework (Qingquan et al., 2020). Despite its lower energy consumption compared to mining, staking still requires energy and does not comprehensively address environmental concerns (Wendl et al., 2023). Therefore, while staking represents a more sustainable alternative, it falls short in fully integrating green economy principles.

*$H_{6c}$: Monetary control significantly mediates between cryptocurrency-staking and green performance.*

**Theoretical Framework**

The diffusion of innovation (DOI) theory, conceptualized by Rogers in 1962, provides a comprehensive framework for understanding the process through which new ideas, technologies, or practices disseminate within a societal or organizational context. The theory outlines several critical components influencing this adoption process: the innovation itself, communication channels, the temporal dimension, and the social system (Rogers, 2003). According to Rogers, innovations proliferate through a population in a phased manner, beginning with early adopters, moving through the majority, and ultimately reaching laggards. The rate and extent of this diffusion are determined by several factors, including the perceived advantages of the innovation, its alignment with existing values and needs, its complexity, trialability, and observability.

In applying the DOI theory to the study of digital currencies, such as CBDCs and cryptocurrencies, it becomes evident that these innovations are at various stages of adoption within global financial systems (Rogers et al., 2014). Digital currencies represent a transformative shift from traditional monetary systems, offering potential benefits such as enhanced transaction efficiency, expanded financial inclusion, and novel value creation mechanisms (Radic et al., 2022). The theory suggests that the adoption line of these digital currencies will vary based on how different stakeholders (ranging from governments to financial institutions and individual users) perceive their relative benefits, ease of integration, and compatibility with existing financial and regulatory frameworks (Kim et al., 2022). The theory suggests that the diffusion process of digital currencies will be influenced by stakeholders' perceptions of the innovations' advantages and compatibility (Yoo et al., 2020). Such as, CBDCs may experience accelerated adoption if they are perceived as enhancing monetary control and economic stability, thereby yielding significant economic benefits. Conversely, the diffusion of cryptocurrency mining may be hindered by its high energy consumption and associated environmental concerns, reflecting growing sustainability apprehensions (Koloseni and Mandari, 2024).

The theory also provides valuable insights into the role of monetary control as an intervening factor between digital currencies and their economic and environmental impacts. As digital currencies evolve and integrate into the broader economic landscape, the role of monetary authorities becomes crucial in managing their adoption (Tule and Oduh, 2017). The DOI theory highlights the necessity for effective communication, regulation, and policy adjustments to optimize the benefits and mitigate the drawbacks of these innovations (Bell and Feng, 2019). By understanding the stages and factors influencing the diffusion of digital currencies, policymakers develop strategies that enhance economic performance while addressing environmental sustainability concerns (Koloseni and Mandari, 2024). Thus, the DOI theory presents a robust theoretical framework for examining the implications of digital currencies on economic and environmental performance. It highlights the importance of considering the adoption process's phases and the pivotal role of monetary control in facilitating or impeding this process. As digital currencies continue to evolve, their successful integration will depend on how effectively their benefits are communicated, their alignment with existing systems is achieved, and how they are managed within the regulatory environment. The study's conceptual framework in shown in Figure 1.

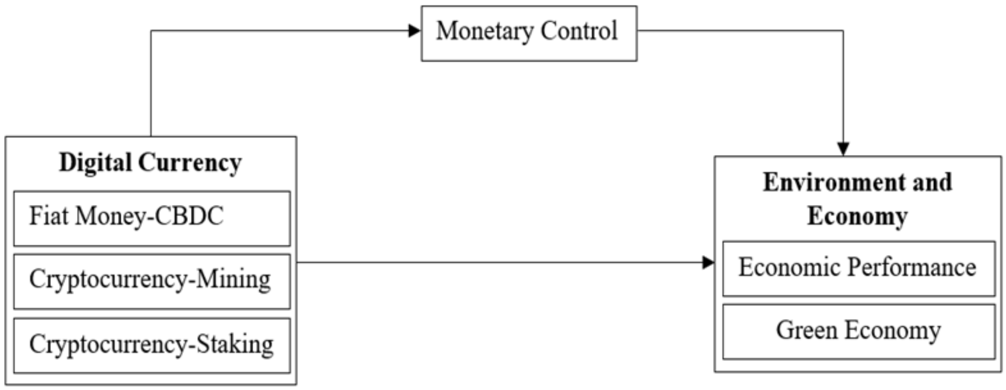


**Figure 1: Conceptual Framework**

## METHODOLOGY

### Data Collection and Sampling

This research employed a quantitative deductive methodology, wherein hypotheses were tested against the data collected to determine their validity. The survey was administered and distributed online via Google Forms, enabling broad access to participants across Pakistan. To ensure relevant insights, we selected respondents based on specific criteria: individuals working in banks or currency exchange institutions, those with existing knowledge in currencies, and investors or traders actively participating in cryptocurrency markets.

Given the inherent anonymity and decentralized nature of cryptocurrencies, there are no existing records specifically tracking Pakistani users. Consequently, a non-probability sampling method was deemed appropriate for this study. In addition to being cost-effective, non-probability sampling is sufficient to meet the requirements of the survey without necessitating extreme precision (Brick, 2014). To further refine the sampling process, the study utilized a snowball sampling technique, a strategy commonly employed when the target population with specific characteristics is challenging to identify (Naderifar et al., 2017).

Considering the expansive nature of the target population and the impracticality of engaging every individual, Cochran's sample size formula was employed to determine an appropriate sample size. With a 95% confidence level, a 5% margin of error, and an estimated population proportion of 0.5, the sample size was reduced to a manageable 385 participants. Snowball sampling was utilized to address the challenge of identifying a precise number of individuals possessing expertise in digital and cryptocurrencies, as well as the requisite experience and practice at the time of the study. This method, based on referrals (Heckathorn, 2011), effectively facilitated access to a substantial number of informed participants across the country. This approach has seen increasing adoption in contemporary research (Aliu and Aigbavboa, 2023; Aghimien et al., 2022). A total of 600 questionnaires were initially distributed, resulting in 438 completed responses, corresponding to a 73% response rate of the intended sample size. Prior research has indicated that, due to the inherent challenges in achieving large sample sizes in surveys, a response rate of 20%-30% is considered adequate for drawing valid conclusions (Moser and Kalton, 1999).

### Instrument

In this study, all variables were evaluated using self-reported instruments. Considering that English is the official language of communication in Pakistan and prior studies have validated the effectiveness of English-language measures within this context (Raja et al., 2020), the survey was conducted in English. Most respondents held graduate degrees, which mitigated any challenges in understanding and completing the survey.

**Table 1: Measures**

| Variable Name | Variable Type | No. of Items | No. of Items Deleted | Source |
|---|---|---|---|---|
| Fiat Money-CBDC (CBDC) | Independent | 8 | 0 | Khan et al. (2020) |
| Cryptocurrency-Mining (CRPM) | Independent | 8 | 0 | |
| Cryptocurrency-Staking (CRPS) | Independent | 8 | 1 | |
| Monetary Control (MPC) | Mediating | 7 | 0 | Rana et al. (2024), Filardo and Guinigundo (2008) |
| Economic Performance (ECP) | Dependent | 15 | 9 | Zhu et al. (2008), |
| Green Economy (GRE) | Dependent | 12 | 3 | Paulraj (2011), Yong et al. (2020) |

The study relied on well-established, previously validated scales to assess the variables of interest. Responses were collected using a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). The selection of a five-point Likert scale is widely supported by scholars (Dawes, 2008) due to its clarity, simplicity, and tendency to improve response rates. Moreover, given the online administration of the survey, a five-point scale was considered the most suitable option. The specific items employed to measure each variable, drawn from a range of established sources, are outlined in Table 1.

**Econometric Technique**

The study's data analysis was conducted through structural equation modelling (SEM), a robust statistical technique designed to examine complex interrelationships among variables. A maximum likelihood estimation method within SEM was utilized to precisely assess both the structural and measurement models (Hair et al., 2023). Confirmatory factor analysis (CFA) was employed to validate the convergent validity and evaluate the causal linkages between the revised items and the latent constructs in the measurement model (Abbasi et al., 2021). CFA plays a critical role in verifying the alignment of observed variables with the latent constructs they are intended to measure, thereby ensuring the adequacy of the model's fit (Hair et al., 2011). After the CFA, the structural model was applied to explore the relationships between predictors and outcomes. The SEM analysis was conducted using Smart-PLS4, a variance-based software well-suited for predictive modeling (Hair et al., 2020). Smart-PLS offers significant advantages, including its ability to handle non-normally distributed data and its support for nonparametric multigroup analysis, which facilitates comparing different sample groups within the dataset (Hair et al., 2023).

## DATA ANALYSIS AND RESULTS

To ensure the measurement model's robustness, convergent, and discriminant validity were examined utilizing Smart-PLS4. In addition, an independent samples t-test was conducted to identify any potential non-response bias in the study. The analysis demonstrated that Levene's test for equality of variances produced values exceeding 0.05 across all constructs, aligning with the criteria suggested by Pallant (2011). This result suggests that non-response bias is not a concern in this study. Moreover, to further validate the reliability and integrity of the measurement model, a comprehensive collinearity assessment was performed to evaluate the presence of common method variance (CMV). According to the standards proposed by Hair et al. (2016), the variance inflation factors (VIF) observed for all constructs were below the critical threshold of 5 (see Table 2). These results indicate that CMV does not affect the model, thereby strengthening the validity of the study's findings.

**Measurement Model: Reliability and Validity**

CFA was performed using maximum likelihood estimation for each construct to confirm the reliability and validity of the measurement model. The reliability and internal consistency of the model were evaluated through composite reliability and Cronbach's Alpha. The analysis revealed that all constructs surpassed the accepted benchmarks for both composite reliability and Cronbach's Alpha (>0.70), indicating robust internal consistency and reliability across the model (see Table 2).

Convergent validity was assessed by calculating the average variance extracted (AVE) and analyzing the factor loadings of each construct. The results showed that all constructs had an AVE exceeding the minimum recommended threshold of 0.50 (Hair et al., 2023). Additionally, the factor loadings for all items were above the 0.70 threshold (Hair et al., 2023), further supporting the establishment of convergent validity (Table 2).

To evaluate discriminant validity, the Fornell and Larcker criterion was applied. As presented in Table 3, the bold diagonal values were consistently higher than the corresponding off-diagonal values in the same rows and columns, indicating that the constructs were indeed distinct (Fornell and Larcker, 1981). Furthermore, the study utilized the Heterotrait-Monotrait (HTMT) ratio (Henseler et al., 2015), to provide additional confirmation of discriminant validity. According to Table 3, all HTMT values were below the threshold of 0.85, consistent with the criterion suggested by Kline (2023), thereby affirming that discriminant validity was successfully established in this study. Besides, before proceeding with hypotheses testing, we examined the descriptive measures and correlations for all variables (see Table 4). The measurement model of the study is presented in Figure 2.

**Table 2: Measurement Model Assessment**

| Items | Factor Loadings | VIF | Alpha (α) | CR | AVE |
|---|---|---|---|---|---|
| CBDC1 | 0.929 | 4.629 | 0.864 | 0.870 | 0.800 |
| CBDC2 | 0.891 | 3.790 | | | |
| CBDC3 | 0.847 | 3.018 | | | |
| CBDC4 | 0.888 | 3.947 | | | |
| CBDC5 | 0.903 | 4.256 | | | |
| CBDC6 | 0.901 | 4.172 | | | |
| CBDC7 | 0.883 | 3.746 | | | |
| CBDC8 | 0.910 | 4.597 | | | |
| CRPM1 | 0.904 | 4.425 | 0.921 | 0.917 | 0.787 |
| CRPM2 | 0.859 | 3.622 | | | |
| CRPM3 | 0.897 | 4.200 | | | |
| CRPM4 | 0.870 | 3.865 | | | |
| CRPM5 | 0.886 | 3.704 | | | |
| CRPM6 | 0.913 | 4.795 | | | |
| CRPM7 | 0.887 | 4.032 | | | |
| CRPM8 | 0.882 | 3.705 | | | |
| CRPS1 | 0.916 | 4.617 | 0.917 | 0.902 | 0.834 |
| CRPS2 | 0.906 | 4.219 | | | |
| CRPS3 | 0.924 | 4.232 | | | |
| CRPS4 | 0.913 | 4.633 | | | |

| | | | | | |
|---|---|---|---|---|---|
| CRPS5 | 0.899 | 4.004 | | | |
| CRPS6 | 0.916 | 4.800 | | | |
| CRPS7 | 0.917 | 4.709 | | | |
| ECP10 | 0.922 | 4.240 | 0.872 | 0.885 | 0.865 |
| ECP12 | 0.919 | 4.924 | | | |
| ECP15 | 0.895 | 4.477 | | | |
| ECP7 | 0.952 | 3.737 | | | |
| ECP8 | 0.939 | 3.191 | | | |
| ECP9 | 0.952 | 4.404 | | | |
| GRE1 | 0.851 | 3.194 | 0.905 | 0.910 | 0.783 |
| GRE2 | 0.869 | 3.536 | | | |
| GRE3 | 0.901 | 4.246 | | | |
| GRE4 | 0.866 | 3.394 | | | |
| GRE5 | 0.910 | 4.690 | | | |
| GRE6 | 0.900 | 4.793 | | | |
| GRE7 | 0.867 | 4.043 | | | |
| GRE8 | 0.892 | 4.524 | | | |
| GRE9 | 0.905 | 4.621 | | | |
| MPC1 | 0.922 | 3.205 | 0.828 | 0.839 | 0.819 |
| MPC2 | 0.810 | 2.355 | | | |
| MPC3 | 0.919 | 3.004 | | | |
| MPC4 | 0.929 | 4.487 | | | |
| MPC5 | 0.919 | 4.957 | | | |
| MPC6 | 0.916 | 4.632 | | | |
| MPC7 | 0.913 | 4.596 | | | |

Note: VIF: Variance Inflation Factor, CR: Composite Reliability, AVE: Average Variance Extracted, Alpha: Cronbach's Alpha. The items (CBDC8, TIN7, TIN8, GRE10, GRE11, GRE12, ECP1, ECP2, ECP3, ECP4, ECP5, ECP6, ECP11, ECP13, ECP14) with factor loadings less than 0.70 were removed.

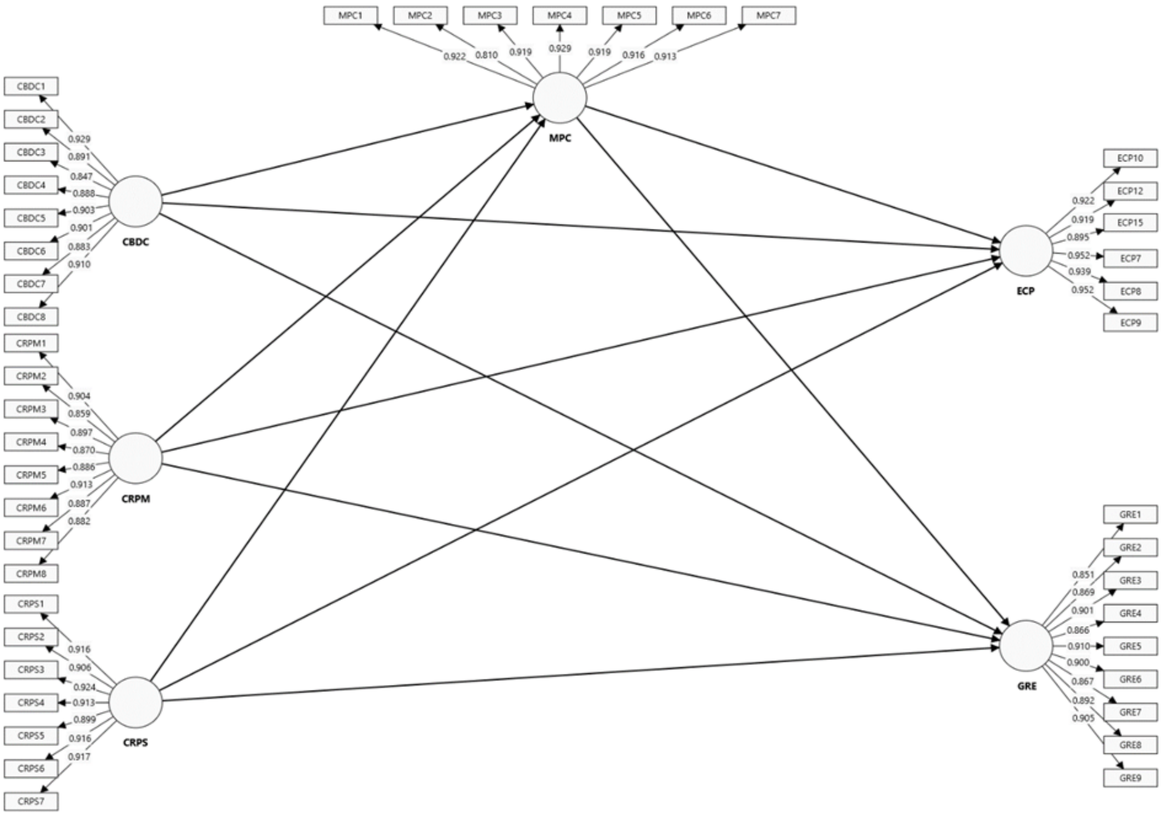


**Figure 2: Measurement Model**

**Table 3: Discriminant Validity**

| **Heterotrait-Monotrait (HTMT) Ratio** | | | | | | |
|---|---|---|---|---|---|---|
| ***Construct*** | ***CBDC*** | ***CRPM*** | ***CRPS*** | ***ECP*** | ***GRE*** | ***MPC*** |
| CBDC | | | | | | |
| CRPM | 0.699 | | | | | |
| CRPS | 0.781 | 0.738 | | | | |
| ECP | 0.599 | 0.701 | 0.749 | | | |
| GRE | 0.585 | 0.605 | 0.603 | 0.610 | | |
| MPC | 0.487 | 0.686 | 0.693 | 0.542 | 0.613 | |
| **Fornell-Larcker Criterion** | | | | | | |
| ***Construct*** | ***CBDC*** | ***CRPM*** | ***CRPS*** | ***ECP*** | ***GRE*** | ***MPC*** |
| CBDC | **0.894** | | | | | |
| CRPM | 0.623 | **0.887** | | | | |
| CRPS | 0.747 | 0.495 | **0.913** | | | |
| ECP | 0.738 | 0.594 | 0.674 | **0.930** | | |
| GRE | 0.576 | 0.593 | 0.595 | 0.600 | **0.885** | |
| MPC | 0.651 | 0.649 | 0.584 | 0.540 | 0.601 | **0.905** |

**Table 4: Descriptive Statistics and Correlations**

| Variable | Mean | St. Dev. | CBDC | ECP | CRPM | CRPS | GRE | MPC |
|---|---|---|---|---|---|---|---|---|
| CBDC | 3.650 | 0.948 | 1.000 | | | | | |
| ECP | 3.617 | 0.937 | 0.573 | 1.000 | | | | |
| CRPM | 3.651 | 0.936 | 0.662 | 0.675 | 1.000 | | | |
| CRPS | 3.761 | 0.980 | 0.647 | 0.467 | 0.647 | 1.000 | | |
| GRE | 3.421 | 1.007 | 0.564 | 0.589 | 0.581 | 0.582 | 1.000 | |
| MPC | 3.705 | 0.991 | 0.451 | 0.559 | 0.448 | 0.657 | 0.589 | 1.000 |

**Structural Model: Hypotheses Testing**

In the subsequent step, SEM was utilized to examine the path models, focusing on both direct and indirect effects. The predictive relevance of the model was assessed using the $Q^2$ statistic, which helps researchers validate the significance of the model's constructs. As illustrated in Table 5, all variables exhibited $Q^2$ values greater than 0, aligning with Chin (1998) guidelines, thereby confirming the model's predictive relevance. Additionally, the $R^2$ statistic was employed to evaluate the model's predictive power, following the criteria established by Cohen (2013). The $R^2$ values for ECP, GRE, and MPC indicated high, moderate, and high predictive power, respectively (Cohen, 2013). The structural model of the study is depicted in Figure 3.

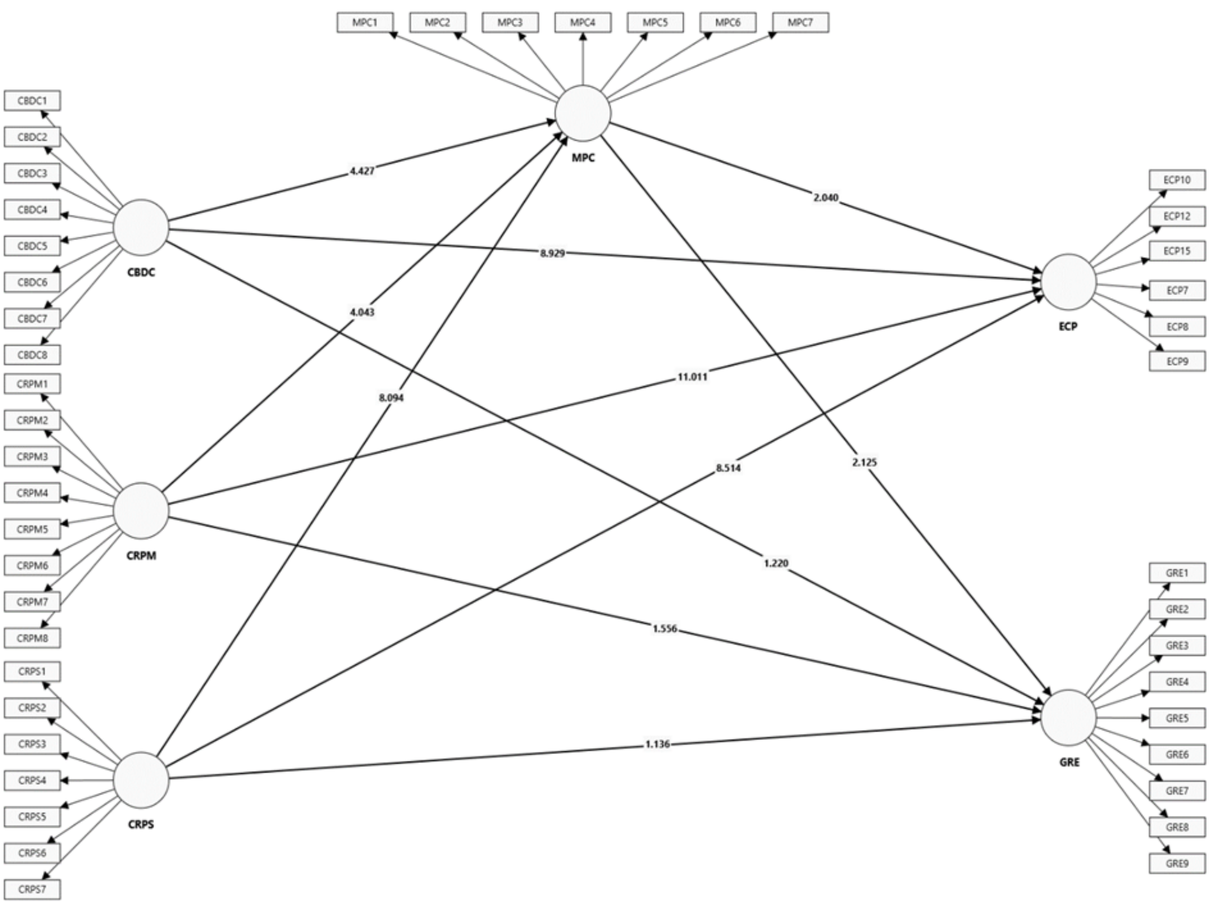


**Figure 3: Structural Model**

**Table 5: Model Predictive Power ($R^2$) and Relevance ($Q^2$)**

| Variable | $R^2$ | $Q^2$ |
|---|---|---|
| ECP | 0.876 (high) | 0.476 (>0) |
| GRE | 0.370 (moderate) | 0.353 (>0) |
| MPC | 0.840 (high) | 0.538 (>0) |

**Direct Paths Analysis**

The findings presented in Table 6 indicate that the direct impact of CBDC (effect: 0.290***, SE: 0.066), CRPM (effect: 0.215***, SE: 0.053) and CRPS (effect: 0.479***, SE: 0.059) on MPC is significantly positive at the 1% level. Additionally, MPC was found to have a significant and positive effect on both ECP (effect: 0.064**, SE: 0.031) and the GRE (effect: 0.357**, SE: 0.168), implying that monetary control contributes to improvements in these areas. This evidence supports $H_{1a\text{-}c}$ and $H_{2a\text{-}b}$. Furthermore, Table 6 reveals that the direct effect of CBDC (effect: 0.312***, SE: 0.035), CRPM (effect: 0.358***, SE: 0.033) and CRPS (effect: 0.270***, SE: 0.032) on ECP, even in the presence of a mediator, is both positive and highly significant at the 1% level, emphasizing the substantial role CBDC, CRPM and CRPS play in fostering ECP, thereby supporting $H_{3a\text{-}c}$. However, when MPC acts as a mediator, the direct effects of CBDC (p>0.10), CRPM (p>0.10) and CRPS (p>0.10) on GRE are not significant, leading to the rejection of $H_{4a\text{-}c}$.

**Table 6: Direct Paths Analysis**

| Path | Estimates | Std. Error | t-value | p-value | Effect Size ($f^2$) | Decision |
|---|---|---|---|---|---|---|
| *Direct Effect (a and b paths)* | | | | | | |
| CBDC → MPC | 0.290*** | 0.066 | 4.427 | 0.000 | 0.087 (weak) | Accepted |
| CRPM → MPC | 0.215*** | 0.053 | 4.043 | 0.000 | 0.046 (weak) | Accepted |
| CRPS → MPC | 0.479*** | 0.059 | 8.094 | 0.000 | 0.316 (moderate) | Accepted |
| MPC → ECP | 0.064** | 0.031 | 2.040 | 0.041 | 0.060 (weak) | Accepted |
| MPC → GRE | 0.357** | 0.168 | 2.125 | 0.034 | 0.082 (weak) | Accepted |
| *Direct Effects in the Presence of Mediator (c' path)* | | | | | | |
| CBDC → ECP | 0.312*** | 0.035 | 8.929 | 0.000 | 0.237 (moderate) | Accepted |
| CRPM → ECP | 0.358*** | 0.033 | 11.011 | 0.000 | 0.312 (moderate) | Accepted |
| CRPS → ECP | 0.270*** | 0.032 | 8.514 | 0.000 | 0.196 (moderate) | Accepted |
| CBDC → GRE | -0.198 | 0.162 | 1.220 | 0.222 | 0.004 (no effect) | Failed |
| CRPM → GRE | 0.265 | 0.170 | 1.556 | 0.120 | 0.006 (no effect) | Failed |
| CRPS → GRE | 0.189 | 0.166 | 1.136 | 0.256 | 0.004 (no effect) | Failed |

***p≤0.01, **p≤0.05, *p≤0.10.

**Mediation Analysis**

To examine the presence of an indirect (mediation) effect, the bootstrapping method was employed, with a bootstrap sample size of 5,000 (Table 7). The bootstrapped findings revealed that the indirect effects of CBDC (effect: 0.019*, SE: 0.011), CRPM (effect: 0.014*, SE: 0.007), and CRPS (effect: 0.031**, SE: 0.016) on ECP, when mediated by MPC, were both positive and significant. This suggests that monetary control serves as a significant mediator between CBDC and ECP, CRPM and ECP, as well as CRPS and ECP, indicating the presence of partial mediation. Consequently, $H_{5a\text{-}c}$ is supported. Similarly, the analysis demonstrated that the indirect effects of CBDC (effect:

0.104*, SE: 0.060), CRPM (effect: 0.077**, SE: 0.035), and CRPS (effect: 0.171**, SE: 0.085) on the GRE, in the presence of MPC as a mediator, were also positive and significant. This indicates that MPC acts as a significant mediator between CBDC and GRE, CRPM and GRE, and CRPS and GRE, revealing full mediation (Table 7). Therefore, $H_{6a-c}$ is validated.

**Table 7: Indirect (Mediation) Effects Analysis**

| Path | Estimates | Std. Error | t-value | p-value | Mediation | Decision |
|---|---|---|---|---|---|---|
| CBDC → MPC → ECP | 0.019* | 0.011 | 1.757 | 0.079 | Complementary (Partial Mediation) | Accepted |
| CRPM → MPC → ECP | 0.014* | 0.007 | 1.899 | 0.058 | Complementary (Partial Mediation) | Accepted |
| CRPS → MPC → ECP | 0.031** | 0.016 | 1.963 | 0.050 | Complementary (Partial Mediation) | Accepted |
| CBDC → MPC → GRE | 0.104* | 0.060 | 1.728 | 0.084 | Indirect Only (Full Mediation) | Accepted |
| CRPM → MPC → GRE | 0.077** | 0.035 | 2.168 | 0.030 | Indirect Only (Full Mediation) | Accepted |
| CRPS → MPC → GRE | 0.171** | 0.085 | 2.004 | 0.045 | Indirect Only (Full Mediation) | Accepted |

***p≤0.01, **p≤0.05, *p≤0.10.

## DISCUSSION

The current study contributes to the debate by highlighting the significant impact of CBDCs, cryptocurrency mining, and staking on monetary control, reflecting their intricate roles in modern financial systems. CBDCs enhance the precision with which central banks manage monetary policy. By embedding CBDCs into the financial infrastructure, central banks can more effectively align monetary strategies with real-time economic conditions, enabling swift adjustments to money supply and better management of inflation and economic disturbances (Ozili, 2023). Cryptocurrency mining and staking, while less directly linked to monetary control, also contribute by influencing market liquidity and currency stability. Staking, through the temporary immobilization of assets, reduces market volatility, indirectly supporting monetary control by fostering a more predictable economic environment (Cipollini, 2024). Mining, despite its decentralized nature, affects the broader monetary ecosystem by introducing new digital assets, impacting liquidity and monetary dynamics (Cong et al., 2022).

Monetary control is also shown to significantly and positively influence both economic performance and green economy initiatives. Effective monetary governance fosters economic stability, which is essential for long-term growth, investment, and innovation. By promoting stability, monetary control mitigates uncertainty, boosts consumer and investor confidence, and supports sustainable economic development (Cobham et al., 2022). Additionally, monetary policies can be strategically directed towards environmentally sustainable investments, aligning financial incentives with ecological objectives (Fu et al., 2023). This approach steers resources towards green projects, driving the transition to a sustainable economy and enhancing the positive relationship between monetary control and green performance.

The positive impact of CBDCs, cryptocurrency mining, and staking on economic performance emphasizes the transformative potential of digital currencies in modern economies. CBDCs improve transaction efficiency, reduce costs, enhance financial inclusion, and stimulate economic activity, particularly in regions with large unbanked populations (Petare et al., 2024). Despite environmental concerns, cryptocurrency mining is crucial for generating new digital assets and contributing to market liquidity, driving economic activity within the digital asset sector (Rana and Al Mamun, 2024). Cryptocurrency staking stabilizes markets, reduces volatility, and increases investor confidence, further fuelling economic growth (Cobham et al., 2022). These findings suggest that when integrated and regulated effectively, digital currencies significantly enhance both economic performance and monetary control, offering new opportunities for development and stability in the digital age.

The insignificant direct impact of CBDCs, cryptocurrency mining, and staking on the green economy is due to their primary focus on financial efficiency, liquidity, and market stability rather than environmental sustainability. CBDCs are designed to enhance monetary control and economic stability, typically without incorporating environmental objectives (Li et al., 2024). Similarly, cryptocurrency mining and staking prioritize network security and profitability, lacking direct mechanisms to address environmental concerns. While these digital assets may indirectly support green initiatives through their economic influence, they do not inherently promote or integrate sustainable practices.

The findings emphasize the critical role of monetary control in amplifying the economic benefits of digital currencies like CBDCs, cryptocurrency mining, and staking. While these assets are inherently designed to improve financial processes, enhance liquidity, and ensure market stability, their full economic potential is realized when integrated into a well-regulated monetary framework. Effective monetary governance allows for precise management of key financial parameters such as money supply, interest rates, and inflation, significantly boosting the positive impact of these digital currencies on economic performance (De Vries, 2023). For instance, central banks can utilize CBDCs to implement targeted monetary policies that stimulate economic activity and maintain currency stability, while regulatory measures can mitigate risks like volatility and liquidity shortages in cryptocurrency markets.

The study also highlights the transformative potential of monetary control in promoting environmental sustainability. Although digital assets are not specifically designed to address environmental issues, monetary control serves as a vital mediator that aligns financial activities with sustainability goals. Full mediation suggests that without the active involvement of monetary authorities, the direct impact of digital currencies on the green economy would be minimal. However, these digital assets can be redirected to support sustainable practices through strategic monetary policies, such as green financing initiatives or penalties for carbon-intensive activities. Regulatory frameworks could also incorporate environmental criteria, ensuring that the economic benefits of cryptocurrency mining and staking contribute to global sustainability efforts. These findings emphasize the essential role of monetary policy in bridging financial innovation and environmental responsibility, ensuring that the rise of digital currencies positively impacts economic growth and sustainability.

## CONCLUSION AND POLICY IMPLICATIONS

### Theoretical Contribution

This research significantly augments the diffusion of innovation theory by providing a detailed examination of how digital currencies (fiat money-CBDC, cryptocurrency mining, and cryptocurrency staking) affect both economic and green performance. Existing literature has predominantly investigated these digital innovations in isolation; however, this study integrates them within a unified analytical framework, addressing a critical gap. By concurrently evaluating the impacts of these digital assets on economic and ecological dimensions, the study provides a novel lens through which the influence of emerging financial technologies on societal outcomes can be understood. This integrated approach enriches the theoretical debate by illustrating how the diffusion of digital currencies precipitates both economic growth and ecological improvements, thus contributing to a more comprehensive understanding of technological innovation within the financial sector.

The research advances theoretical knowledge by exploring the mediating function of monetary control in the nexus between digital currencies and their economic and environmental effects. This novel contribution emphasizes how effective monetary regulation amplifies or tempers the impacts of digital currencies on financial performance and green outcomes. By highlighting monetary control as a critical mediator, the study emphasizes the necessity of robust regulatory frameworks in optimizing the benefits of digital innovations. This theoretical advancement not only addresses a significant gap in the diffusion of innovation theory but also offers crucial insights into how monetary policy shapes the successful adoption and integration of digital currencies, thereby advancing theoretical understanding and practical applications for policymakers and financial regulators.

**Policy Implications**

The findings highlight the critical need to integrate CBDCs, cryptocurrency mining, and staking into national monetary policies, given their significant positive effects on monetary control. CBDCs, in particular, should be strategically developed and incorporated into existing financial systems to enhance central banks' ability to manage monetary policy with greater precision. This integration is expected to capitalize on the benefits of CBDCs, such as increased transaction efficiency, improved financial inclusion, and enhanced capacity for inflation management. Additionally, the positive impact of cryptocurrency mining and staking on economic performance suggests that regulatory frameworks should be established to encourage responsible and sustainable practices within these domains. Such frameworks might include incentives for energy-efficient mining and support for staking activities, thereby contributing to market stability and improving overall economic growth.

Considering the pivotal role of monetary control in linking digital currencies to environmental performance, it is advisable for policymakers to implement green monetary policies that leverage the potential of CBDCs, cryptocurrency mining, and staking to advance green performance. This could entail the formulation of policies that promote the utilization of CBDCs and cryptocurrencies in financing green initiatives, such as investments in renewable energy, thereby aligning financial incentives with environmental objectives. Additionally, it would be prudent to introduce regulations ensuring that cryptocurrency mining and staking operations adhere to rigorous environmental standards, including measures to reduce carbon emissions and incorporate renewable energy sources. By integrating these environmental considerations into the monetary control framework, policymakers can ensure that the economic benefits of digital currencies are aligned with the advancement of the green economy, thereby supporting long-term ecological and economic bounciness.

The mediating role of monetary control emphasizes the necessity for policymakers to adeptly integrate and employ monetary control mechanisms to fully harness the economic potential of these digital currencies. It is imperative for central banks to formulate and implement comprehensive regulatory frameworks that govern CBDCs and cryptocurrency-related activities. Such frameworks should enable precise modulation of key monetary variables, including interest rates and money supply, in response to the evolving land of digital currencies. By adopting these measures, central banks can stabilize the economy, promote sustainable growth, and optimize the benefits derived from digital assets in alignment with broader economic goals.

The complete mediation of monetary control between digital currencies and the green economy highlights the capacity of effective monetary policy to drive environmental sustainability. In light of these findings, it is essential for policymakers to embed environmental considerations into the regulatory and operational oversight of digital assets. This could involve instituting policies that incentivize green investments facilitated through CBDCs and imposing rigorous environmental standards on cryptocurrency mining and staking activities. For instance, central banks could support renewable energy projects through CBDC transactions and enforce regulations that mandate the use of renewable energy in cryptocurrency operations. These actions would align the economic benefits of digital currencies with environmental sustainability objectives, thereby advancing both financial innovation and ecological stewardship.

**Limitations and Future Directions**

This study provides valuable insights into the impact of digital currencies on economic and environmental outcomes in Pakistan but has notable limitations. The analysis is limited to specific digital currencies without considering other emerging assets like stablecoins, DeFi tokens, or NFTs. Future research should include these additional digital instruments to offer a more comprehensive view of their effects on economic and environmental variables. In addition, while the study highlights monetary control as a key mediator, it overlooks other potential mediators and moderators such as financial literacy, technological infrastructure, and regulatory frameworks. Future studies should explore how these factors influence digital currency impacts and examine additional outcomes like social equity, technological innovation, and market volatility. Understanding how digital currencies affect social equity and technological advancement, as well as their role in market volatility, could provide deeper insights into their broader implications for financial systems and societal development. Addressing these aspects will contribute to a more robust theoretical framework for analyzing the multifaceted impacts of digital currencies.

## CONCLUSION

This research offers an in-depth analysis of the impact of digital currencies (fiat money- CBDC, cryptocurrency mining, and cryptocurrency staking) on economic and green performance within the Pakistani context. By examining the critical role of monetary control as a mediator, the study highlights its essential function in maximizing the economic advantages of these digital innovations while concurrently addressing their environmental consequences. The evidence establishes that monetary control plays a significant mediating role between digital currencies and both economic and ecological outcomes, thus emphasizing the necessity for advanced regulatory frameworks to optimize these interactions. It is imperative for central banks to devise and implement policies that harness the benefits of digital currencies for economic advancement while ensuring that these measures align with broader environmental objectives. The implications of these findings are particularly relevant to Pakistan, where the adoption of CBDCs and cryptocurrency activities holds the potential to significantly enhance economic performance and foster financial inclusion amidst existing environmental challenges. The study supports the formulation of green monetary policies that encourage sustainable practices in cryptocurrency mining and staking operations. By promoting the utilization of CBDCs for funding renewable energy initiatives and enforcing stringent environmental standards for digital currency operations, policymakers can effectively reconcile economic growth with ecological stewardship. Such measures will not only stabilize the economy but also advance environmental sustainability, ensuring that digital finance innovations contribute constructively to a country's developmental goals.

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