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RESEARCH PAPER

Artificial Neural Network Insights: Ranking Digital Currencies for Pakistan's Economic and Green Performance

[1]Faisal Iqbal* and [2]Sofia Anwar

1. PhD Scholar, Department of Economics, Government College University, Faisalabad, Punjab, Pakistan
2. Professor, Department of Economics, Government College University, Faisalabad, Punjab, Pakistan

***Corresponding Author:** faisal.grewal@gmail.com

ABSTRACT

The evolution of money from traditional forms to digital innovations emphasizes the transformative role of digital currencies. This study investigates the transition from traditional money systems to blockchain-based innovations, emphasizing the growing role of digital currencies. It aims to examine the comparative impacts of CBDCs, cryptocurrency mining, and staking on economic performance and green economy. The study uses a quantitative deductive approach, collecting data through online surveys from 438 respondents. Artificial neural network analysis is applied to assess the impact of digital currencies and rank the predictors. The findings highlight CBDCs as the leading driver of economic performance due to their efficiency and inclusivity, while cryptocurrency staking positively impacts both economic and environmental goals. Conversely, cryptocurrency mining poses significant challenges, with its high energy consumption and declining viability. The study recommends adopting CBDCs, promoting energy-efficient staking models, and enforcing strict environmental regulations on cryptocurrency mining for balanced policy development.

KEYWORDS Central Bank Digital Currency, Cryptocurrency, Economic Performance, Green Economy, Mining, Staking

Introduction

The evolution of money, from barter systems to modern digital currencies, reflects humanity's quest for efficient and secure mediums of exchange. In the 17th century, barter systems, though foundational, were plagued by inefficiencies such as difficulty in determining exchange rates and quality discrepancies in traded goods (Mishra et al., 2024). These challenges highlighted the need for a universal medium of exchange, paving the way for traditional currencies like paper money, which have become the backbone of modern economies due to their government-backed trust and widespread acceptance (Naguib, 2023). However, as economies expanded, the limitations of carrying physical cash (especially for large transactions) became evident. This gave rise to centralized digital fiat currencies in the 1990s, such as credit and debit cards, which allowed banks to serve as intermediaries, ensuring transaction security while charging processing fees. While digital fiat currencies mitigated risks associated with physical cash, they introduced challenges like the double-spending problem, where users could spend beyond their balances (Eke et al., 2023). Blockchain-based cryptocurrencies emerged as a revolutionary solution to these challenges, leveraging decentralization and consensus mechanisms like Proof-of-Work (PoW) to ensure transaction fidelity. Bitcoin, the pioneering cryptocurrency, operates outside government control, offering benefits such as reduced transaction costs, enhanced anonymity, and innovative investment opportunities (Fujiki, 2024). Though, issues like value volatility, hacking risks, and the absence of regulatory oversight have limited their widespread adoption. Amidst this backdrop, new paradigms like Central Bank Digital Currencies (CBDCs) and cryptocurrency staking (CRPS) have gained traction, each with unique implications for economic performance and environmental sustainability (Agur, et al., 2023). CBDCs, issued and regulated by central banks, offer a blend of security, efficiency, and inclusivity, addressing many limitations of traditional and digital fiat currencies (Eke et al., 2023). On the other hand, CRPS represents an energy-efficient alternative to cryptocurrency mining (CRPM), utilizing blockchain technology to support the digital economy while reducing environmental impact (Chamanara et al., 2023).

The relationship between digital currencies and their impacts on economic and green performance is multifaceted and warrants critical examination. CBDCs, often touted as a secure and regulated solution, are not without challenges. While they promote financial inclusion and reduce transaction costs, their centralized nature may raise concerns about surveillance, data privacy, and potential overreach by authorities, which could undermine trust among users (Tan, 2024). CRPM, although driving technological innovation and investment, remains a significant contributor to environmental degradation due to its excessive energy consumption and resultant carbon emissions, directly conflicting with global sustainability goals (Zhang et al., 2023). CRPS, often lauded as an eco-friendly alternative, has limitations in its scalability and ability to fully mitigate the environmental footprint of blockchain technology (Wendle et al., 2023). In the context of Pakistan, where economic vulnerabilities and energy crises prevail, a critical evaluation of these digital currencies is crucial. Addressing the complexities and trade-offs of digital currencies is essential to understanding their varied impacts on economic and green performance, enabling the development of balanced and sustainable strategies. This study, thus, aims to compare and rank CBDCs, CRPM, and CRPS in terms of their impact on Pakistan's economic performance and green economy using an Artificial Neural Network (ANNs) approach. By investigating the degree of influence each digital currency model exerts, the research provides actionable insights into how Pakistan can harness digital finance for sustainable economic growth and environmental stewardship. The motivation for this study stems from the growing influence of digital currencies on economic systems and their environmental implications. As economies like Pakistan transition towards digital finance, understanding the comparative impact of CBDCs, CRPM and CRPS becomes critical. While CBDCs present opportunities for economic stability and inclusion, CRPM's energy-intensive operations pose significant environmental challenges. Conversely, CRPS offers a more sustainable blockchain validation method.

This study makes a distinct contribution by critically examining and comparing three forms of digital currencies (CBDCs, CRPM and CRPS) to assess their respective impacts on economic performance and the green economy. Unlike prior research that often focuses on individual digital currencies in isolation, this study adopts a comprehensive approach by ranking these currencies using an ANNs methodology. By evaluating their influence on both economic and environmental dimensions, this research identifies the most impactful currency, offering actionable insights for policymakers and stakeholders seeking to balance technological innovation with sustainable development.

Literature Review

The rise of digital currencies, such as cryptocurrencies and CBDCs, has significantly disrupted traditional financial systems, altering how individuals transact and invest. Cryptocurrencies like Bitcoin, while innovative, remain far from replacing the extensive and entrenched global network of traditional currencies (Fujiki, 2024). By the end of 2023, the total value of U.S. currency in circulation reached approximately $2.26 trillion, distributed across 54.6 billion notes. The U.S. dollar continues to dominate global foreign exchange reserves, holding more than three times the value of the euro. Furthermore, the dollar's share in global payments has climbed to 49.1%, solidifying its position as a cornerstone of international finance. Although determining the exact proportion of U.S. currency held overseas remains difficult, its widespread use in global transactions and status as a reserve currency suggest a significant amount circulates beyond U.S. borders. The anonymity associated with cryptocurrencies mirrors the discreetness of physical cash, yet traditional fiat currencies, like the $100 bill, require no technological infrastructure, making them more accessible to a broader population.

Cryptocurrencies' decentralized nature eliminates intermediaries, such as banks, during transactions, offering reduced fees and faster cross-border payments (Nabilou, 2019). However, their anonymous and unregulated characteristics present significant risks, including their potential use in illegal activities and black-market transactions (Arnone, 2024). Additionally, the speculative nature and extreme price volatility of cryptocurrencies deter widespread adoption, as their value fluctuates unpredictably, causing uncertainty for investors and users alike. The lack of government backing further undermines their security and trustworthiness for the general populace, making traditional fiat currencies remain a safer and more stable medium of exchange (Dhali et al., 2024).

Blockchain technology, the foundation of cryptocurrencies, is frequently lauded for its potential to revolutionize modern digital transactions. Its decentralized and transparent ledger system has far-reaching applications beyond cryptocurrencies, potentially transforming sectors like healthcare, logistics, and finance (Owolabi et al., 2024; Zulfiqar et al., 2023). However, the nascent stage of cryptocurrencies raises concerns about scalability, security, and widespread adoption. While blockchain technology could integrate seamlessly into existing financial systems to enhance transparency and efficiency, its energy-intensive operations, especially in cryptocurrency mining, present significant environmental challenges (Anwer et al., 2023; Huo et al., 2023).

Previous studies have explored comparative evaluation techniques for digital currencies. For instance, Khan et al. (2020) employed the TOPSIS method to assess different mediums of currency exchange, emphasizing its utility in addressing complex decision-making scenarios. Similarly, Krohling and Pacheco (2015) highlighted the robustness of such methods in ranking evolutionary algorithms. These methodologies align with the current study's objective to evaluate the relative impact of CBDCs, CRPM and CRPS on economic performance and the green economy. Thus, following hypotheses are developed:

H_1: Digital currencies (CBDCs, cryptocurrency mining and staking) significantly influence economic performance.

H_2: Digital currencies (CBDCs, cryptocurrency mining and staking) significantly influence green economy.

Material and Methods

Data Collection and Sampling

This study used a quantitative deductive approach to test hypotheses through data collected from respondents in Pakistan. The survey, distributed online via Google Forms, targeted individuals working in banks, currency exchange institutions, and cryptocurrency markets. Given the lack of records on Pakistani cryptocurrency users, a non-probability sampling method with snowball sampling was employed to identify participants with relevant expertise. Cochran's formula determined a sample size of 385, with a 95% confidence level and 5% margin of error. A total of 600 questionnaires were distributed, yielding 438 completed responses, achieving a 73% response rate. Snowball sampling, based on referrals, proved effective in accessing informed participants. This approach aligns with prior research addressing hard-to-reach populations and ensures adequate representation despite challenges in achieving large sample sizes.

Instrument and Variables

This study used self-reported measures to evaluate all variables. Given that English serves as the official language of communication in Pakistan and previous studies have confirmed the validity of English-language instruments in this context (Raja et al., 2020), the questionnaire was administered in English. To measure the study variables, scales that were both well-established and previously validated were adopted. Responses were recorded on a five-point Likert scale. For an online survey format, a five-point scale was deemed the most practical and effective choice. Details of the specific items used to assess each variable, sourced from established frameworks, are provided in Table 1.

Table 1
Instrument and Variables

Variable	Definition	Items	Source
Independent Variables			
Fiat Money-CBDC	Fiat Money-CBDC (Central Bank Digital Currency): A digital version of a country's official money, created and controlled by the central bank, meant to make transactions safer and more efficient while keeping the same value as regular money.	8	Khan et al. (2020)
Cryptocurrency-Mining (CRPM)	The process of verifying and adding transactions to a blockchain by solving complex math problems, which rewards the person doing the work with new cryptocurrency.	8	
Cryptocurrency-Staking (CRPS)	A way to earn rewards by holding and locking up cryptocurrency in a digital wallet, which helps support the network's operations, like confirming transactions, in systems that use proof-of-stake technology.	7	
Dependent Variables			
Economic Performance (ECP)	How well an economy or business is doing, usually measured by factors like income, profits, and financial growth.	6	Zhu et al. (2008), Paulraj (2011), Yong et al. (2020)
Green Economy (GRE)	An economy that aims to grow while protecting the environment, focusing on clean energy, reducing pollution, and conserving natural resources.	9	

Econometric Strategy

Artificial neural networks (ANNs) were employed in this study due to their superior predictive accuracy (Zabukovšek et al., 2019). Specifically, the Multilayer Perceptron (MLP) model was selected for its adaptability to the indicators under examination and its compatibility with regression analyses. The MLP architecture consists of three fundamental layers: input, output, and a hidden layer. The hidden neurons are generated automatically. The hyperbolic tangent activation function is utilized in the hidden layer, while the sigmoid function is applied in the output layer. These activation functions serve to evaluate the neural network's performance (hidden layer) and the regression model's validity (output layer). The strength of connections between neurons and the nature of relationships (whether direct or indirect) are determined by synaptic weights. To ensure the network architecture aligns optimally with the dataset, an additional bias parameter is incorporated. The dataset is partitioned into training and testing subsets, and the model's predictive accuracy is assessed through ten-fold cross-validation (Ooi and Tan, 2016). The ANN model's performance is further validated by calculating the Root Mean Square Error (RMSE), as outlined in Equation-1 (Mehedintu and Soava, 2023).

$$RMSE = \sqrt{\frac{1}{N} \times SSE} \text{ -------- } (1)$$

Where, N denotes number of predictors and SSE indicates sum of squares error.

Results and Discussion

The model was evaluated using ANNs via SPSS software, with Cronbach's Alpha values (Table 2, Column 1) demonstrating excellent reliability (Hair et al., 2020). These results confirm the consistency and reliability of the data, ensuring robust analysis. The mean and median scores for CBDC, CRPM, CRPS, ECP, and GRE are 3.650, 3.651, 3.761, 3.617, and 3.421 (mean) and 4.000, 4.000, 4.143, 4.000, and 3.889 (median), respectively. These scores reflect a positive central tendency across all variables, with most responses clustering toward higher values, indicating favorable outcomes. The skewness (-0.728 to -1.525) and kurtosis (2.278 to 4.174) values fall within acceptable ranges, signifying normal data distribution (Byrne and Van de Vijver, 2010). This supports the validity of parametric statistical techniques applied to analyze the dataset, as normality is a key assumption for these methods.

Table 2
Reliability and Descriptive Statistics

Variable	Alpha	Mean	Median	Std. Dev.	Skewness	Kurtosis
CBDC	0.865	3.650	4.000	0.948	-1.442	3.808
CRPM	0.920	3.651	4.000	0.936	-1.507	3.958
CRPS	0.917	3.761	4.143	0.980	-1.525	4.083
ECP	0.873	3.617	4.000	0.937	-1.551	4.174
GRE	0.905	3.421	3.889	1.007	-0.728	2.278

Artificial Neural Networks (ANNs) Analysis

An ANN analysis was conducted to rank predictors and explore relationships between variables, with CBDC, CRPS and CRPM in the input layer and ECP and GRE in the output layer. The multilayer perceptron model utilized a hyperbolic tangent activation function for the hidden layer and a sigmoid function for the output layer. Covariates were normalized for standardization. The model indicated strong predictive performance, with average relative errors of 0.031 (ECP) and 0.102 (GRE) in the testing phase and 0.036 (ECP) and 0.192 (GRE) in the training phase.

Figure 1 illustrates the multilayer perceptron model, highlighting the positive influence of CRPS, CBDC and CRPM on ECP. Figure 1 also highlights the positive effect of CRPS and CBDC on GRE and a negative influence of CRPM on GRE. Synaptic weights >0 confirm these positive relationships (and <0 for negative relationship), with larger block sizes and thicker connecting lines signifying stronger variable impacts. Table 3 summarizes the key predictors identified by the model, detailing the connections between input variables (CRPS, CBDC and CRPM) and the output variables (ECP and GRE). Hence, H_1 and H_2 are accepted.

Table 3
Estimation of Multilayer Perceptron (MLP) Parameters

Exogenous Variables		Endogenous Variables		Endogenous Variables	
		Hidden Layer 1	Output Layer	Hidden Layer 1	Output Layer
		H (1:1)	ECP	H (1:1)	GRE
Input Layers	(Bias)	-0.577	---	-2.548	---
	CRPS	0.141	---	0.183	---
	CBDC	0.148	---	0.920	---
	CRPM	0.133	---	-0.063	---
Hidden Layer 1	(Bias)	---	-0.807	---	-0.268
	H (1:1)	---	3.056	---	1.122

To optimize the ANN model, the dataset was divided into training and testing subsets, with proportions varying across the two ANNs as part of the parameter optimization process (Table 4). The RMSE was utilized to evaluate prediction accuracy for both subsets. Each neural network underwent 10 iterations, resulting in a consistent reduction in RMSE values (approaching zero), which indicates a strong model fit and high predictive accuracy (Zabukovšek et al., 2019). Among the two configurations, ANN10 emerged as the most effective model for the analysis.

A sensitivity analysis was performed to assess the predictive importance of each input neuron, with results presented in Table 5. The analysis quantified the normalized importance of these neurons by computing the ratio of their relative importance to the maximum importance observed, expressed as percentages (Karaca et al., 2019). For the dependent variable ECP, the findings revealed that CBDC (100%) was the most impactful predictor, followed by CRPS (94.5%), and CRPM (84.3%). Regarding the dependent variable GRE, CRPS (100%) emerged as the most significant predictor, followed by CBDC (56.4%), and CRAPM (1.8%). These rankings are also depicted in Figure 2. Notably, all predictors indicated positive effects on the outcomes (ECP and GRE), except for external biases, which negatively influenced both ECP and GRE, and CRPM, which exhibited a negative impact on GRE.

Table 4
RMSE Scores for the ANN Model

Neural Network	Training		Testing		Training		Testing	
	SSE	RMSE	SSE	RMSE	SSE	RMSE	SSE	RMSE
ANN1	1.469	0.700	0.992	0.575	0.346	0.340	0.159	0.230
ANN2	1.179	0.627	0.981	0.572	0.318	0.326	0.142	0.218
ANN3	1.134	0.615	0.857	0.534	0.302	0.317	0.140	0.216
ANN4	1.062	0.595	0.841	0.529	0.296	0.314	0.126	0.205
ANN5	0.972	0.569	0.784	0.511	0.275	0.303	0.120	0.200
ANN6	0.963	0.567	0.753	0.501	0.271	0.301	0.120	0.200
ANN7	0.848	0.532	0.742	0.497	0.271	0.301	0.113	0.194
ANN8	0.830	0.526	0.661	0.469	0.259	0.294	0.109	0.191
ANN9	0.786	0.512	0.641	0.462	0.255	0.292	0.104	0.186
ANN10	0.509	0.412	0.489	0.404	0.251	0.289	0.087	0.170
---	Mean	0.565	Mean	0.506	Mean	0.308	Mean	0.201

Table 5
Sensitivity Analysis (Ranking the Predictors)

Predictors	ECP			GRE		
	Relative Importance	Normalized Importance	Ranking	Relative Importance	Normalized Importance	Ranking
CRPS	0.339	94.5%	2	0.632	100.0%	1
CBDC	0.359	100.0%	1	0.356	56.4%	2
CRPM	0.302	84.3%	3	0.012	1.8%	3

Discussion

The findings present a deep understanding of how CBDC, CRPM, and CRPS differentially influence ECP and the GRE in Pakistan, offering both empirical clarity and actionable insights. The dominance of CBDC as a predictor of ECP (100%) reflects its unparalleled role in transforming monetary policy execution and economic stability. CBDCs enable central banks to implement precision-driven policies, reduce transaction inefficiencies, and promote financial inclusion by integrating unbanked populations into formal economies (Tan, 2024). Their transparency reduces corruption risks and streamlines cross-border payments, directly enhancing ECP (Ozili, 2024). Furthermore, the strong performance of CRPS (94.5%) as a contributor to ECP highlights its appeal in the digital economy. By leveraging staking mechanisms, participants earn rewards without incurring the prohibitive energy costs of mining, thus fostering a sustainable yet profitable ecosystem (Khosravi and Säämäki, 2023). Conversely, CRPM's lower yet significant contribution (84.3%) to ECP highlights its declining economic viability due to rising operational costs, regulatory scrutiny, and environmental concerns (Ozili, 2024; Hakimi et al., 2024). Together, these results highlight a strategic opportunity for Pakistan to adopt CBDCs for macroeconomic robustness while promoting CRPS as a scalable, energy-conscious alternative to mining.

In the context of GRE, the findings further emphasize the transformative potential of CRPS, which emerges as the most critical factor (100%). The energy-efficient nature of staking aligns directly with the goals of a green economy, making it a cornerstone of sustainable blockchain technologies. Staking reduces the environmental footprint of cryptocurrency operations by eliminating the energy-intensive computational processes inherent in mining (Wendl et al., 2023). On the other hand, CBDC's moderate impact on GRE (56.4%) reveals its secondary role in environmental sustainability, with its primary benefits tied to economic efficiency rather than ecological outcomes (Alonso, 2023; Kousar et al., 2023). CRPM's negligible contribution to GRE (1.8%) is consistent with its energy-intensive and environmentally detrimental profile, emphasizing the urgency of phasing out mining practices in favor of greener alternatives (Tayebi and Amini, 2024). The negative influence of external biases on both ECP and GRE further highlights the importance of mitigating macroeconomic instabilities, policy inconsistencies, and external shocks to fully realize the potential of these digital assets. Similarly, the adverse impact of CRPM on GRE reinforces the necessity of regulatory and market-driven initiatives to discourage unsustainable practices. These findings advocate for a robust policy framework that prioritizes CBDC implementation and CRPS adoption, ensuring economic advancement without compromising environmental integrity in Pakistan.

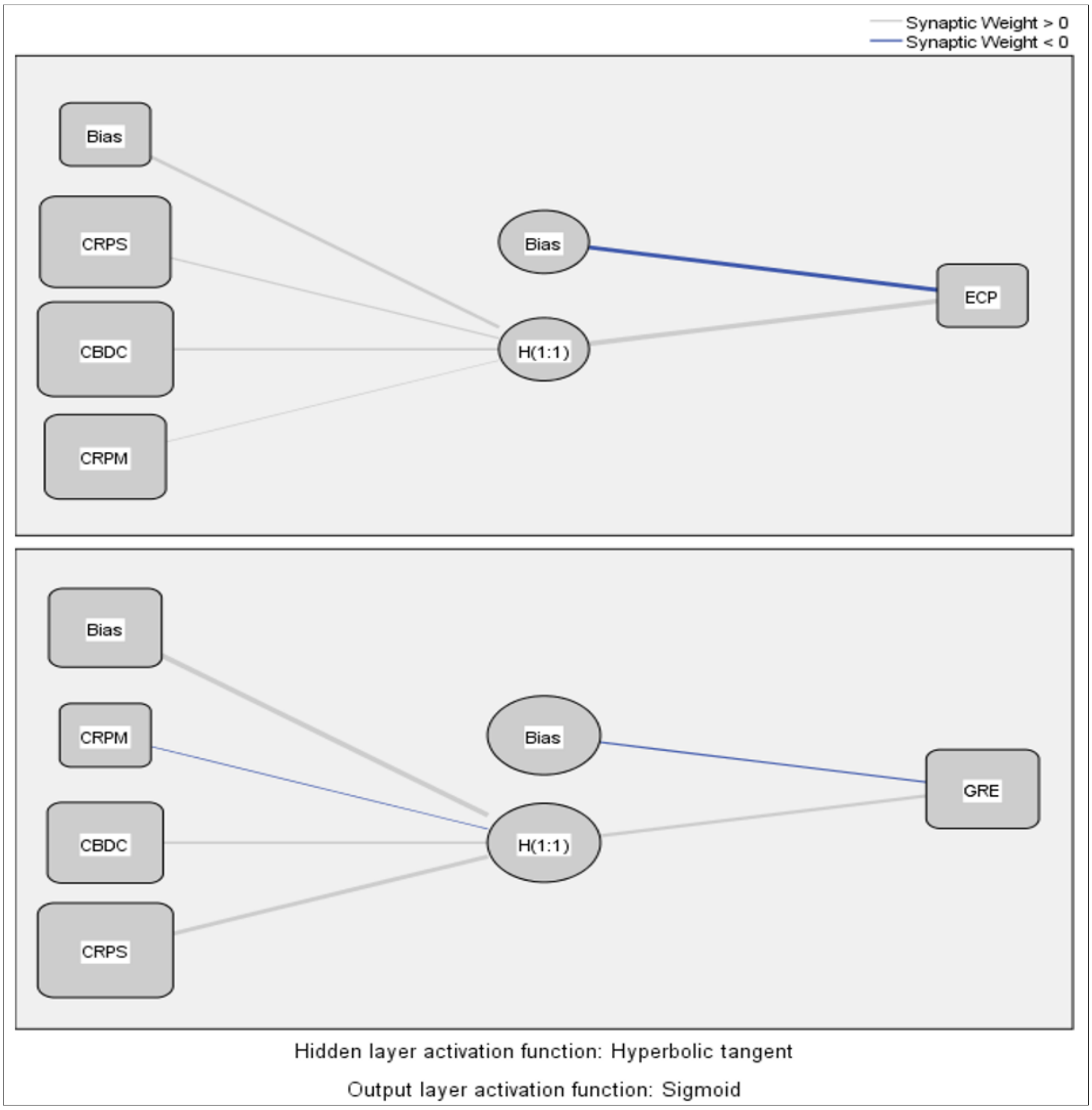

Figure 1: Multilayer Perceptron for ECP and GRE

The findings highlight the critical need for policymakers in Pakistan to strategically leverage CBDC and CRPS to achieve two key objectives: enhancing ECP and promoting the green economy. It is essential that the State Bank of Pakistan prioritize the gradual integration of CBDCs, supported by a comprehensive regulatory framework that guarantees secure implementation, transaction transparency, and compatibility with the existing financial infrastructure. CBDCs present an opportunity to resolve persistent inefficiencies in the traditional financial system, foster financial inclusion by integrating underserved communities, and reduce the dependence on cash transactions, thereby stimulating formal economic activity. Policymakers should also focus on building public trust in CBDCs through targeted awareness campaigns and provide incentives for businesses to adopt CBDC-based transactions. The notable connection between CRPS and ECP further highlights the significance of promoting cryptocurrency staking, particularly through financial incentives such as tax breaks, grants, or subsidies for blockchain initiatives that prioritize energy-efficient staking protocols. Such measures would not only mitigate the environmental impact of traditional cryptocurrency mining but also position Pakistan as an attractive destination for global investment in the blockchain sector.

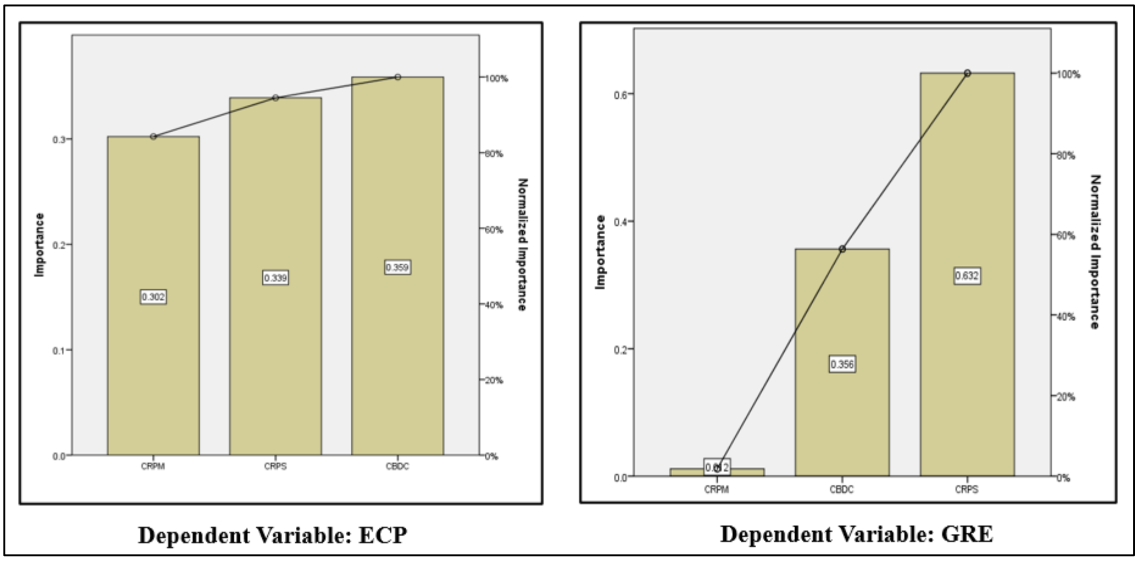

Figure 2: Ranking of Predictors

In relation to the green economy, CRPS's dominant role in influencing GRE emphasizes the necessity of crafting specific policies to encourage its widespread adoption. Regulatory bodies should integrate energy efficiency requirements into the country's cryptocurrency frameworks, creating incentives for projects that meet green sustainability objectives. This could include the establishment of certification systems for blockchain protocols that utilize staking, alongside the creation of industry-wide sustainability benchmarks to drive environmentally responsible growth. While CBDCs demonstrate a moderate effect on GRE, incorporating renewable energy solutions into their underlying technological infrastructure could significantly enhance their environmental footprint. Additionally, policymakers must address the minimal contribution of CRPM to the green economy by implementing stricter environmental regulations, such as phasing out energy-intensive mining practices, imposing carbon taxes on non-compliant activities, and enforcing emissions standards. By simultaneously developing economic stability and reducing environmental risks, these measures will ensure that Pakistan's digital financial ecosystem promotes both long-term economic growth and ecological sustainability.

Conclusion

The evolution of money, from traditional systems to blockchain-based innovations, highlights the growing influence of digital currencies on economic and environmental landscapes. As economies like Pakistan transition toward digital finance, examining the comparative impacts of CBDCs, CRPM, and CRPS on ECP and green economy becomes critical for developing balanced strategies. This study, thus, provides a comprehensive analysis of the differential impacts of CBDCs, CRPM, and CRPS on both ECP and the green economy in Pakistan, offering valuable insights for policymakers. The findings clearly establish CBDCs as the most influential factor in driving ECP, with its potential to enhance financial inclusion, reduce inefficiencies, and streamline monetary policy execution. However, CRPS emerges as a critical factor not only for its positive contribution to ECP but also for its pivotal role in supporting a sustainable, energy-efficient digital ecosystem, emphasizing its potential to align economic growth with environmental objectives. In contrast, CRPM's energy-intensive nature and declining economic viability underscore its negative implications for both ECP and GRE, calling for urgent regulatory interventions to phase out mining practices in favor of greener alternatives. The study also highlights the importance of addressing external biases and ensuring macroeconomic stability to optimize the positive impacts of CBDCs and CRPS. The research advocates for a balanced policy approach that prioritizes the integration of CBDCs, incentivizes the adoption of energy-efficient staking models, and imposes stringent environmental regulations on CRPM. This integrated strategy will not only strengthen Pakistan's economic resilience but also advance its green economy, positioning the country as a leader in sustainable digital finance.

This study has limitations, particularly in its focus on the impact of CBDCs, CRPS, and CRPM on ECP and the GRE in Pakistan, which may limit the generalizability to other countries with different economic and regulatory contexts. Future research could explore additional variables such as regulatory uncertainty, market sentiment, monetary control and technological infrastructure in blockchain to deepen understanding of their interaction with economic and environmental outcomes. Additionally, investigating the socio-cultural implications and behavioral responses of various demographic groups in Pakistan could provide valuable insights into the broader societal effects of digital financial systems.

Recommendations

The study highlights the necessity for a comprehensive policy framework that emphasizes the adoption of CBDCs and CRPS while addressing the environmental concerns associated with CRPM. A gradual implementation of CBDCs by the State Bank of Pakistan, supported by well-defined regulatory frameworks, is recommended to ensure secure operations, transparency, and integration with the existing financial system. Building public confidence in CBDCs can be achieved through targeted educational initiatives and incentives aimed at encouraging their use by businesses. To maximize the economic and ecological advantages of CRPS, policymakers should introduce financial support mechanisms, including tax incentives and grants, for blockchain projects prioritizing energy-efficient staking technologies. Developing certification standards and sustainability criteria can further incentivize environmentally responsible innovations. To address the detrimental environmental effects of CRPM, urgent measures are required, such as enforcing stringent environmental regulations, gradually eliminating energy-intensive mining activities, and introducing carbon taxation on non-compliant operations. Incorporating renewable energy sources into the technological framework of CBDCs could significantly enhance their environmental sustainability. By aligning economic development with ecological preservation, these strategies can enable Pakistan to establish itself as a global leader in sustainable digital finance, ensuring both economic growth and environmental stewardship.

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