UDC 336.741.2:339.7
DOI: https://doi.org/10.17721/1728-2292.2025/2-61/21-32
JEL: E42, F33, G15, O33, G21

Serhii TSYHANOV, DSc (Econ.), Prof.
ORCID ID: 0000-0002-9032-7829
e-mail: S_Tsyganov@knu.ua
Taras Shevchenko National University of Kyiv, Kyiv, Ukraine

Andrii BUZ, PhD Student, Assist.
ORCID ID: 0000-0003-0074-0693
e-mail: andrii_buz@knu.ua
Taras Shevchenko National University of Kyiv, Kyiv, Ukraine

DIGITAL RECONSTITUTION OF MONETARY ONTOLOGY: INSTITUTIONAL PRECONDITIONS FOR CURRENCY INTERNATIONALISATION IN THE AGE OF TOKENISED VALUE

Background. ***The emergence of central bank digital currencies (CBDCs) and cryptocurrencies – forms of money instantiated as code – has catalysed a foundational reappraisal of monetary ontology. Classical theory draws a distinction between the ontic status of money (what money is) and its ontological conditions (how it becomes socially recognised as such). Tokenisation disrupts this distinction by embedding monetary functions within programmable digital architectures. This study interrogates how the advent of tokenised value and programmable money compels a reassessment of monetary being, with particular attention to their implications for currency internationalisation.***

Methods. ***The study employs a qualitative mixed-method design combining theoretical modelling and comparative case analysis. A conceptual framework – the functional continuum of moneyness – is developed using a three-dimensional metric based on the classical functions of money. Documentary analysis of monetary theory and international practice supports the framework, while comparative case vignettes (e.g., e-CNY, Onyx, e-Naira) illustrate institutional variation.***

Results. ***Findings reveal that tokenisation collapses the traditional dichotomy between monetary sign and payment infrastructure, rendering transference a built-in function of digital money. Smart contracts and protocol-layer enforcement facilitate autonomous execution of monetary rules – an emergent phenomenon described here as programmable sovereignty. The study presents a typology of ledger architectures – ranging from permissionless public blockchains to account-based state systems – each exhibiting distinct implications for trust, composability, and cross-border reach. Institutional preconditions for international circulation are analysed across legal, governance, interoperability, and privacy dimensions. Crucially, the research formulates a hypothesis: a cryptocurrency that functionally matches or exceeds the "moneyness" of the weakest recognised fiat currency may be deemed money in the global domain, regardless of state endorsement.***

Conclusions. ***Digitisation reconstitutes money as a programmable institutional object, expanding the ontological spectrum of what may qualify as currency. However, the potential for international scale depends on whether digital tokens meet key institutional thresholds: legal recognition or toleration abroad, credible governance, technological interoperability, and alignment between privacy protections and regulatory compliance. The framework developed herein offers a theoretical basis and testable propositions for evaluating the internationalisation trajectories of digital monies, including their capacity either to circumvent or to become embedded within existing global monetary hierarchies.***

Keywords: ***monetary ontology; tokenised value; currency internationalisation; international macroeconomics; cryptocurrencies; digital finance; central bank digital currency; programmable money; international monetary and financial system; international financial architecture; financial stability; economic integration; macroeconomic policy.***

Background

The accelerating digitalisation of money, particularly through tokenisation technologies, has foregrounded an ontological reconfiguration of monetary forms within the international monetary and financial system (IMFS). As financial infrastructures increasingly encode value into programmable tokens, long-standing conceptual binaries between money as a legal construct and as a market medium are rendered inadequate. This technological upheaval not only disrupts institutional routines but also demands a rethinking of what money is, how it emerges, and under what institutional conditions it can transcend domestic confines to assume international functions. The proliferation of central bank digital currencies (CBDCs), decentralised cryptocurrencies, and hybrid synthetic constructs – ranging from stablecoins to consortium-issued tokens – has underscored a fundamental epistemic gap in the literature: namely, the absence of a unified framework to assess the ontological legitimacy of emergent digital forms of money. In particular, the binary approach that treats state-issued fiat as the only legitimate monetary form fails to account for the consensual, networked, and functional characteristics of digitally native instruments. At the same time, the scope of currency internationalisation remains normatively tethered to traditional metrics – such as foreign exchange turnover, invoicing share, and reserve composition – that are agnostic to the ontic transformations digitalisation introduces.

Against this backdrop, ***the aim of this article*** is twofold. First, to map the ontological transformation of money as it is re-inscribed into digital code and governed by increasingly autonomous institutional architectures. Second, to theorise the institutional preconditions that allow digital monetary instruments to cross the threshold from domestic to international use, based on a criteria-based approach that accounts for technological, legal, and governance-specific determinants.

Literature overview. The ontological foundations of money have long been debated across economic, legal, and philosophical traditions. Classical commodity theories posit intrinsic value as the basis of money's legitimacy, while chartalist and institutionalist schools emphasise state authority and legal tender status (Knapp, 1924; Ingham, 2004; Desan, 2014). More recent approaches – particularly within social ontology – shift the focus from money's material substrate to its performative enactment through collective intentionality and institutional structures (Searle, 1995; Larue, 2024). Digitalisation has reinvigorated these

debates by introducing forms of money that neither derive value from state decree nor from intrinsic materiality, but rather from code-based consensus mechanisms. Distributed ledger technologies (DLT) instantiate what Ikpeazu (2023) describes as a "programmable ontology of money", where institutional facts are embedded within technical protocols. Halaburda, Haeringer, and Sarvary (2022) argue that tokenisation represents a new mode of financial representation, collapsing the traditional dichotomy between monetary sign and payment rail. Nicolini and Intini (2024) further highlight that cryptocurrencies challenge the idea of monetary sovereignty by externalising monetary governance to algorithmic rule systems.

On the question of international use, Cohen (1998; 2018) delineates the functions of an international currency – unit of account, medium of exchange, and store of value across borders – as contingent on state power, market depth, and financial infrastructure. However, this framework remains grounded in fiat paradigms and does not accommodate the ontology of digital tokens. Rey (2015) and Eichengreen and Viswanath-Natraj (2022) note that international monetary power is increasingly tied to technological infrastructures and platform-based network effects, suggesting that currency internationalisation in the digital age may require different analytical tools. Current CBDC research (Bindseil et al., 2021; Bank for International Settlements et al., 2021; Lloyd, 2023) has explored legal and infrastructural implications, yet few studies propose ontological criteria for recognising digital tokens as international money. Aneja and Dygas (2024) identify token interoperability, governance structures, and data jurisdictionality as pivotal to cross-border usability. Meanwhile, the IMF and FSB have highlighted the risks of monetary fragmentation in the absence of shared governance norms (Financial Stability Board, & International Monetary Fund, 2024). These contributions, while foundational, have not yet produced a unified theory capable of ranking both sovereign and decentralised digital monetary instruments according to their international functional capacity. This article seeks to bridge this gap by proposing a functional continuum model of money and testing its applicability in digital contexts.

Methods

This study adopts a mixed-method qualitative design grounded in theoretical-explanatory and comparative-illustrative strategies. The core methodological apparatus integrates theoretical methods-operations such as analysis, synthesis, abstraction, idealisation, and modelling, complemented by dialectical theory construction and documentary analysis as key methods of action. At the heart of the inquiry lies the development of a conceptual model – the functional continuum of moneyness – formulated within a three-dimensional metric space corresponding to the classical functions of money: unit of account, medium of exchange, and store of value. The methodology proceeds in four stages: (1) theoretical construction of the continuum model; (2) documentary analysis of international monetary practices and digital currency frameworks; (3) comparative examination of selected case vignettes (e.g., e-CNY, Onyx, e-Naira); and (4) normative application of a proposed "recognition lemma" for evaluating cryptocurrencies' eligibility for global monetary status. This methodology allows for a grounded, criteria-based assessment of digital instruments' eligibility for recognition within the international monetary system and provides an ontologically sound alternative to traditional fiat-centric taxonomies.

Results

The international monetary system is undergoing a structural transformation as digital tokens and code increasingly substitute physical money and centralised ledgers. The ongoing shift – the advent of tokenised value and programmable money –necessitates a re-examination of money's ontological foundations. Rather than being defined solely by ontic features (e.g. state issuance), money is reconceptualised as an institutional fact emerging from relational claims embedded in technological and legal structures. Digitalisation collapses the divide between monetary sign and payment infrastructure, positioning money as an engineered object circulating within distributed ledger technologies (DLT). Grounded in a relational-institutional perspective, this study views money as a collectively recognised claim embedded in governance frameworks and legal norms. Classical theories, such as Knapp's chartalism and Searle's status-function ontology, emphasise collective intentionality as the basis for monetary legitimacy. In the digital sphere, DLT facilitates programmable consensus, allowing peer-to-peer networks to validate monetary claims without a central authority. In such systems, consensus emerges through protocol rather than decree, opening the possibility for non-sovereign digital tokens to attain monetary status (Aneja, & Dygas, 2024). A range of perspectives on the monetary nature of digital assets is summarised in Table 1.

Table 1

Perspectives on digital currencies and the definition of money

Perspective	Representative views	Summary
Etatist / Chartalist – Sovereign legitimacy (Money requires state issuance and legal tender status)	Knapp's Chartalism; Central bankers (e.g. Ingves et al., 2022)	Money is a legal construct deriving value from state endorsement, tax enforceability, and legal tender status. Cryptocurrencies, lacking sovereign backing, are excluded from this framework and classified as private speculative financial assets outside the official monetary system
Sceptical – Crypto lacks monetary qualities (Digital assets fail essential monetary criteria)	Yermack (2015); BIS (2022); Nicolini, & Intini (2023)	Cryptocurrencies, particularly Bitcoin, exhibit high volatility and limited use in real transactions, undermining their role as a unit of account or store of value. Without nominal anchors or monetary cohesion, they are unsuitable as monetary bases and remain speculative instruments
Functional / Emergent – Moneyness via use (Instruments become money through functional performance)	Menger; Searle's institutional ontology (Caton, 2020)	Money can emerge when a token is widely used and accepted for exchange, valuation, and savings. Legal status is secondary to actual usage. Cryptocurrencies or stablecoins may acquire moneyness if they consistently fulfil monetary functions across user networks
Techno-Optimist – Crypto as transformative money (Digital currencies can redefine global monetary order)	Fintech advocates; Bitcoin maximalists (e.g. Bhatia, 2021)	Digital tokens are seen as revolutionary tools to transcend national barriers and reconfigure global finance. Bitcoin is posited as a potential universal reserve. Innovations such as smart contracts and decentralised platforms may enable private or hybrid currencies to rival or replace weak state monies, despite regulatory and technological constraints

Source: developed by the author.

Despite technological advances, prevailing definitions remain binary – treating money as either legally sanctioned or not. That prevailing binary framework neglects cases where cryptocurrencies function monetarily despite lacking state recognition. To address this, the article proposes a criteria-based continuum for defining money, assessing instruments by their performance across three classical functions: unit of account (alternatively – measure/standard of value), means of payment (medium of exchange), and store of value (store of wealth). This generates a three-dimensional metric – "moneyness volume" – enabling the functional comparison of monetary instruments, including decentralised tokens. On this basis, we advance the hypothesis that if a given cryptocurrency equals or exceeds the moneyness volume of the weakest recognised national currency, it qualifies as universal money in the global, extrajurisdictional sphere – essentially an a-national or transnational space (virtual space) where parties transact by mutual agreement. This functional recognition is grounded in consensual usage and collective intentionality, rather than state coercion. For example, if a cryptocurrency sustains purchasing power and facilitates widespread transactions on par with a fragile fiat currency, it fulfils the threshold criteria for monetary recognition in transnational space – even if excluded from domestic legal frameworks.

Importantly, this proposition applies to global, virtual domains where usage is voluntary. It does not imply equivalence within sovereign jurisdictions unless explicitly permitted by the state. Domestic legal tender status remains subject to national discretion. Thus, a digital token may qualify as money internationally, while lacking legal status in most domestic systems. By advancing a functional continuum approach, this study integrates cryptocurrencies and programmable monies into the broader hierarchy of money, positioning them along a spectrum of moneyness rather than outside the monetary order. This conceptual repositioning enables a more inclusive analysis of currency internationalisation, recognising degrees of global monetary functionality rather than relying solely on state endorsement.

Relational-institutional ontology of money in a digital world

Money as an institutional fact re-inscribed in code. In philosophical and institutional terms, money is defined not by its physical form but as a socially constructed institution – what Searle (1995) terms a "status function," whereby a token is collectively accepted as money within a particular context (Desan, 2014; Ikpeazu, 2023; Larue, 2024). Its legitimacy rests on collective intentionality and constitutive rules rather than intrinsic properties. The state plays a role by codifying and enforcing this recognition, but social acceptance remains central. Carl Menger's theory similarly posits that money can emerge organically when a community converges on a specific token's use as a general medium of exchange, independent of legal sanction. In such cases, once general acceptability is established, the token acquires self-reinforcing monetary status. Chartalist theory, advanced by Knapp, contrasts this by arguing that money is fundamentally a legal construct, created through state authority (Knapp, 1924). Under this view, state designation (e.g. legal tender status and acceptance for tax obligations) is essential to monetary value. Modern fiat currencies exemplify chartal money. Cryptocurrencies, lacking sovereign backing, are non-chartal and thus excluded from official monetary status. This position is echoed in central bank discourse, such as the Riksbank's 2018 statement that Bitcoin lacks the support and value stability required to be classified as money. While the functional-emergent and chartalist approaches are conceptually distinct, they coexist within the international monetary and financial system (IMFS), historically dominated by state currencies (Ingham, 2004). The rise of cryptocurrencies challenges this paradigm by embedding monetary claims in code and consensus algorithms rather than centralised institutions. Cryptocurrencies such as Bitcoin exemplify a technological re-inscription of monetary ontology – transposing social trust from legal institutions to decentralised digital protocols. This constitutes a significant ontological shift.

Distributed ledger technology (DLT) provides the infrastructure for this transformation. A distributed ledger maintains a shared, tamper-evident record of ownership through consensus protocols rather than a central authority. In Searle's terms, these protocols create new constitutive rules: transactions validated by a decentralised network serve as the basis for recognising ownership. Trust, traditionally supplied by legal or institutional mechanisms, is now internal to the system – secured by cryptography and protocol design. Rather than creating trust ex nihilo, DLT redistributes it across decentralised technological and social architectures. Money's foundational credit-debt relationships persist but are now instantiated through code. This technological shift raises fundamental questions about monetary authority. In DLT-based cryptocurrencies, issuance and governance derive from protocol rules and network consensus, bypassing sovereign control. While this challenges chartalist assumptions, it also reveals functional limitations: cryptocurrencies often lack price stability and unit-of-account utility. However, stablecoins address some of these weaknesses by pegging digital assets to fiat currencies (Eichengreen, & Viswanath-Natraj, 2022). Simultaneously, central banks are adopting permissioned DLT for central bank digital currencies (CBDCs), merging state control with distributed infrastructures. In such cases, the central bank retains node oversight while deploying tokenised, blockchain-based systems – another mode of ontological re-inscription.

The result is a pluralistic monetary environment where various forms – fiat, corporate-issued, and decentralised tokens – coexist, each grounded in different institutional foundations (legal, technological, contractual). Within this context, a binary definition of money becomes insufficient. The proposed continuum of moneyness provides a more nuanced analytical tool, allowing assessment based on practical function: unit of account (U), medium of exchange (E), and store of value (S). This produces a composite metric $M = f(U, E, S)$. A currency's moneyness diminishes if it fails in any one dimension, while national currencies set the minimum functional threshold for money. If a cryptocurrency achieves an M-score equal to or greater than the weakest sovereign currency (e.g. one undermined by inflation or poor acceptance), it may be considered money functionally, even without legal status. Historical precedents support this: populations have often opted for more stable foreign currencies or commodities over volatile domestic ones, based on practical performance rather than legal designation. This continuum framework prioritises collective consent and transactional performance over legal fiat. If participants consistently treat an asset as money, it functionally becomes so – especially when usage scales globally. Yet states may resist this redefinition, defending their monetary sovereignty through regulation. The framework does not prescribe normative judgments but

facilitates comparative evaluation across the spectrum of monetary functionality. In conclusion, the ontology of money in the digital era is fundamentally relational and institutional, grounded in evolving architectures of trust and recognition. Tokenisation transforms the infrastructure of money but not its social character – it reconfigures it within new technological domains.

Digital bearer instruments and the dissolution of the sign/rail dichotomy. Classical monetary systems maintained a conceptual divide between money as a *sign* – the unit of value expressed via tokens or ledger entries – and money as *movement*, i.e. the payment infrastructure facilitating its transfer. Paper banknotes, as bearer instruments, combine sign and transfer in one act. In contrast, deposit money requires messaging rails (e.g. cheques, wires, SWIFT) to initiate value transfers, with settlement dependent on institutional reconciliation. This decoupling of sign and rail led to a complex, often inefficient infrastructure – especially for cross-border payments – where multiple ledgers, intermediaries, and legal regimes must interoperate.

Tokenisation technology collapses this divide. A digital bearer token on a distributed ledger (e.g. blockchain) is both the record and the instrument of value. Its transfer updates the ledger in real time and constitutes immediate, final settlement. The ledger becomes a single, shared source of truth – eliminating the need for third-party verification, reconciliation, or clearinghouses. This convergence mirrors cash-like functionality in digital form, with near-instant, borderless transfers operating outside traditional banking constraints. Furthermore, tokenisation introduces programmability. Blockchain-based smart contracts embed executable rules into tokens, enabling conditional and automated transactions without human mediation. Monetary logic can thus be enforced through protocol rather than law. Programmable money can, for instance, expire, restrict usage types, or execute payment only upon fulfilment of specific criteria. This shift from legal to computational enforcement reconfigures monetary governance. As noted by Buterin and others, a smart contract functions as a persistent script, predefining permitted behaviours and reducing discretionary human intervention.

The implications are twofold. On the one hand, programmability enhances efficiency and security – enabling atomic settlement, delivery-versus-payment, and trustless escrow via tools such as hashed time-lock contracts. On the other hand, it raises ethical and governance concerns: protocol-level constraints may reduce flexibility and embed value judgments in code. If tokens become selectively spendable based on use case, money's fungibility may erode. This moves political and normative debates – e.g. over privacy, censorship, or control – into the technical architecture of financial systems. Ontologically, programmable tokens reveal the plasticity of monetary properties. Money can now be instantiated with embedded behaviour – interest accrual, spending restrictions, selective transparency, or compliance logic – reflecting both functional design and normative intent. Zero-knowledge proofs can enable privacy-preserving validation, while embedded blacklists or KYC conditions can enforce legal restrictions at the protocol level. As some commentators observe, tokenised money encodes not only value but values, with embedded governance shaping user behaviour beyond the reach of human override. The collapse of the sign/rail distinction and the rise of programmable rules demonstrate a co-evolution of money's form and function. Technological architecture no longer merely facilitates money but constitutes it. Internationally, this has transformative potential. A supranational token offering real-time settlement without correspondent banks could operate as global digital cash. Conversely, a CBDC may embed jurisdiction-specific rules – blocking outbound flows or enforcing domestic restrictions – making currency usage contingent on national protocol logic. Tokenisation alone does not guarantee internationalisation; outcomes depend on design choices and governance frameworks.

Technological architectures enabling tokenised value

Typology of ledgers: from public blockchains to hybrid CBDCs. Digital currencies operate across a range of backend architectures, each with distinct implications for governance, scalability, and international use:

• *public, permissionless blockchains* refer to open networks such as Bitcoin and Ethereum, where anyone may validate transactions and no central authority governs the ledger. These pure blockchains maximise decentralisation and censorship-resistance through cryptographic consensus mechanisms (e.g. proof-of-work, proof-of-stake). However, they are not readily usable by central banks without significant modification, as they lack controllability and do not support unilateral policy intervention. While offering transparency and openness, they face limitations in scalability and regulatory alignment;

• *private, permissioned blockchains* restrict participation to a predefined set of trusted validators, typically within a centralised or consortium-managed framework. Control is exercised via a designated authority (e.g. a notary node), which simplifies consensus and enhances performance. Central banks have adopted such architectures in sandbox experiments, including Sweden's e-krona pilot and Thailand's Inthanon project (Ashfaq et al., 2023). Although more efficient and scalable than public chains, private blockchains reduce decentralisation and innovation potential and may still involve a centralised governance structure;

• *consortium or public-permissioned blockchains* occupy an intermediate position. These networks restrict validation to selected stakeholders but allow broader participation than private systems. In a consortium chain, several institutions – often including multiple central banks – jointly maintain the ledger. The m-CBDC Bridge, involving several Asian monetary authorities, exemplifies this model. Public use of tokens may be permitted, even if block validation remains limited. These architectures offer shared governance, cross-border interoperability, and institutional oversight, with central banks acting as gatekeepers rather than sole authorities;

• *account-based centralised ledgers* offer a non-blockchain alternative. Here, a central operator (usually the central bank) maintains user accounts and processes all transactions internally. Payments involve debiting and crediting centralised balances, with identity verification required for access. Unlike token-based systems, value transfer relies on account holder authentication, not the token's integrity. While technically simpler and compatible with existing infrastructures, this model lacks features such as peer-to-peer transferability and offline functionality;

• *hybrid models* integrate multiple elements. combine elements from the above architectures. A common approach is the two-tier CBDC, where the central bank issues tokens to intermediaries who then distribute them to users. Ledger responsibilities may be distributed, or tokens may operate with embedded rules (e.g. usage restrictions or co-signature requirements). Another variant is the synthetic CBDC, in which private issuers provide digital

currency backed by central bank reserves, combining state-backed settlement with private token issuance. Some models utilise modular design, deploying DLT for wholesale functions (e.g. interbank settlement) while retaining conventional account-based structures for retail use. Day-to-day transactions may occur off-chain, with periodic settlement on a blockchain to balance efficiency and transparency.

These architectural distinctions critically influence internationalisation potential. Public blockchains offer open global access but lack stability and formal acceptance. Account-based CBDCs are jurisdictionally constrained unless bilateral agreements extend access. Consortium DLTs provide built-in interoperability but demand complex governance coordination. Each structure offers different trade-offs in control, scalability, and inclusivity. Three illustrative scenarios clarify this:

1. *Bitcoin (public blockchain):* universally accessible and censorship-resistant, Bitcoin allows 24/7 transfers. However, volatility, limited throughput, and environmental concerns hinder its viability as a global medium of exchange. Its decentralised governance enhances robustness but impedes adaptability.
2. *Retail CBDC (account/token-based):* China's e-CNY, while domestically focused, is exploring cross-border pilots. Use abroad depends on PBoC authorisation and host-country legal frameworks. Despite technological feasibility, international uptake relies on negotiated interoperability.
3. *Multi-CBDC consortium (e.g. mBridge):* these networks aim to streamline cross-border payments through shared DLTs and atomic swaps. Success hinges on harmonised standards and joint governance. Challenges include ensuring interoperability across differing legal and technical regimes.

Ledger design thus shapes feasibility, trust, and control. Centralised models demand full trust in the operator; permissionless models require trust in protocols and decentralised consensus; consortium models depend on shared institutional governance. Each redistributes rather than eliminates trust. Greater decentralisation may enhance resilience and access but introduces technical and governance complexities. Looking ahead, quantum computing presents a systemic risk. Algorithms underpinning cryptographic security (e.g. RSA, ECC) may become vulnerable. The shift to quantum-resistant cryptography is essential (Nili et al., 2024). Future international trust in a digital currency may depend on its cryptographic agility, positioning quantum resilience as a prerequisite for global monetary credibility.

Architectural distinctions in digital currency design critically shape the prospects and limitations of internationalisation. A public, permissionless cryptocurrency such as Bitcoin is globally accessible and resistant to censorship but suffers from volatility, low throughput, and lacks formal monetary backing. Conversely, a centralised account-based central bank digital currency (CBDC) enables tight monetary control and stability but restricts access to non-residents unless supported by bilateral or multilateral agreements. Consortium-ledger architectures for multi-CBDC systems enable cross-border interoperability but require substantial coordination on governance and technical standards. Each architecture thus represents a distinct pathway for a currency to "go digital global". Consider three illustrative scenarios:

• Bitcoin, as a public blockchain asset, can be transferred globally without intermediaries or authorisation. Its decentralised governance and fixed supply foster resilience, but extreme price volatility, energy intensity, and limited scalability hinder its role as an international medium of exchange. In the absence of legal tender status, its cross-border use depends solely on user preference and network effects, functioning more as a speculative store of value than transactional money.

• A retail CBDC such as China's e-CNY remains primarily domestically focused but has begun testing cross-border applications (e.g. via pilots in Hong Kong). Operating on a permissioned DLT, foreign users require approval from the People's Bank of China (PBoC). International use thus hinges on diplomatic and legal frameworks – such as wallet licensing, CBDC swap lines, or legal tender recognition abroad – rather than mere technical capability.

• Consortium-led multi-currency platforms, such as mBridge, link several CBDCs through a shared ledger. These systems aim to replace legacy correspondent banking models with direct, interoperable settlement layers supported by atomic swaps or similar mechanisms. Smaller currencies may benefit from increased usability. However, governance remains complex: participants must align on access controls, dispute resolution, and rule harmonisation, especially where programmability differs across national CBDCs.

Ultimately, ledger design determines key parameters such as scalability, privacy, control, and institutional trust. Trust is not eliminated but reallocated. In centralised systems, it rests entirely with the central authority; in permissionless networks, it lies with the protocol and node consensus; in consortium chains, it is shared among recognised institutions. Greater decentralisation can mitigate single-point failure and promote inclusivity, but introduces risks such as operational fragility and diminished legal finality. Interoperability frictions and governance opacity may deter reliance on highly closed systems. Conversely, fully open systems may be more accessible but harder to integrate with national regulatory regimes.

A final architectural consideration is quantum security. Advances in quantum computing could compromise current cryptographic standards (e.g. RSA, ECC), threatening the integrity of digital currency ledgers. The development of quantum-safe (post-quantum) cryptography is therefore essential. Only systems that adopt quantum-resistant algorithms can maintain user trust under future threat conditions. As such, cryptographic agility is becoming a necessary feature for CBDC resilience. A currency's ontological security – its recognition as a secure, reliable asset – may depend on pre-emptive adaptation. In the international arena, early adoption of quantum-proof standards could provide a strategic advantage, positioning a currency as globally credible and technologically sovereign.

Programmability and composability: money as software. A defining innovation of tokenised money is programmability – the capacity to imbue money with conditional behaviour and create complex financial logic that executes automatically. This allows for programmable payments, such as event-triggered transfers and automated escrow releases, significantly improving efficiency in international transactions. Smart contracts can execute actions like "transfer upon delivery confirmation," with no manual intervention. Monetary authorities can apply conditional seigniorage, embedding monetary policy directly at the unit level. Examples include programmable value decay (e.g., a demurrage feature where balances shrink over time) or growth (e.g., interest-bearing balances). A stimulus token could be programmed to expire if unused within three months. These features, tested in CBDC pilots such as the e-CNY, enable time-bound incentives but may complicate cross-border use unless

exemption settings are provided for international holders. Embedded compliance enables regulatory enforcement – KYC, AML/CFT checks, and tax compliance – to be integrated at the protocol level. For instance, smart contracts can consult a whitelisted or blacklisted address list before validating a transaction. Transfers may carry metadata visible only to authorised parties (e.g., regulators with legal access). Tiered identity regimes allow low-value anonymous transactions while requiring identity disclosure for larger amounts, balancing privacy with regulatory oversight.

Composability – the capacity to plug together modular features or smart contracts like Lego pieces – allows the development of layered financial services (Halaburda et al., 2022). In interoperable systems, cross-border atomic swaps between CBDCs can be executed automatically via smart contracts, e.g., digital euros converting into digital dollars in a single transaction. Commercial banks may build additional credit or risk-sharing features atop public CBDCs, combining public money with private programmability. Standardisation is essential to global integration. Protocols like ISO 20022 and shared APIs facilitate cross-ledger communication. Successful CBDCs must operate within or bridge to these standards to avoid functional isolation. Cross-ledger atomic swaps and "bridge networks" enable real-time transactions between otherwise siloed ledgers, expanding international usability.

To ensure long-term resilience, quantum-safe (post-quantum) cryptography is critical. Quantum computing threatens current algorithms like RSA and ECC, requiring systems to be future-proofed through cryptographic agility. Modular architectures must enable seamless upgrading to new cryptographic standards. The failure to adopt quantum-safe cryptography may undermine a currency's ontological legitimacy; conversely, early adoption could provide a trust advantage. Ultimately, programmability and composability transform money into a platform. Currencies no longer compete solely on macroeconomic strength, but increasingly on features and usability. A highly programmable and integrable CBDC, offering privacy, compliance, and automation, may gain global appeal. In contrast, restrictive or inflexible systems may struggle to attract international users. These design choices will shape not only domestic utility but also the future of monetary sovereignty and cross-border adoption.

Institutional preconditions for international use of digital money

For a digital currency – be it a CBDC, stablecoin, or cryptocurrency – to attain international currency status, it must transcend its national or niche context through more than technological reach. Historically, currencies like the dollar, euro, or pound gained global roles by combining economic power with institutional frameworks that enabled cross-border trust and usability. In the digital era, institutional preconditions remain critical. Four interdependent dimensions define whether a digital currency can be internationally adopted (see Table 2).

Table 2

Key dimensions and questions for internationalising a digital currency

Dimension	Key Issues	Key Questions
Legal	Legal tender status; settlement finality across borders; statutory classification of digital tokens (currency, security, or hybrid); conflict of laws; capital flow regulation	Is legal tender status abroad essential, or is private acceptance sufficient? What ensures finality in cross-border digital payments? Do current laws recognise token settlement, or are new statutes required?
Governance	Control over protocol and monetary policy; governance of permissioned networks (centralised or multi-stakeholder); dispute resolution; integration of on-chain rules with off-chain legal systems	Can foreign CBDC users rely on consistent, non-discriminatory governance? In decentralised systems, what recourse exists for states? In multi-CBDC platforms, are decisions made by vote, consensus, or lead authority?
Interoperability	Technical and semantic compatibility with other systems; adoption of international standards (ISO 20022, API protocols); access to FX conversion and cross-border liquidity; scalability mechanisms	What infrastructure enables domestic tokens to operate globally? Can atomic swaps be executed via smart contracts? Will it connect to cross-border systems (e.g. SWIFT, BIS projects)? Are bridges or universal standards needed to prevent fragmentation?
Data & Privacy	Cross-border data governance; compliance with localisation laws (e.g. GDPR) (Leucci et al., 2023); balance between AML/CFT compliance and user privacy; application of privacy-enhancing technologies (e.g. ZKPs); cybersecurity	Can privacy-preserving tools (e.g. zero-knowledge proofs) support global AML standards? Who controls data in cross-border use (e.g. a digital euro in Africa)? Do stablecoins issued abroad comply with local data laws? How is cybersecurity ensured system-wide?

Source: developed by the author.

Without addressing these dimensions, global adoption remains constrained:

• A digital currency requires legal finality and settlement finality to ensure transactions are recognised and irrevocable across jurisdictions. Current legal reforms, such as UNCITRAL's Model Law and updates to the EU's Settlement Finality Directive, aim to validate DLT-based payments as legally binding. While foreign CBDCs or crypto-assets rarely obtain legal tender status abroad, broader legal recognition – enforceability of contracts, lawfulness of holdings, and acceptance for settlement – is essential. Regulatory clarity over asset classification (e.g. money, property, security) shapes taxation, access by financial institutions, and applicability of capital controls (FSB, & IMF, 2024). For asset-backed stablecoins, legal mechanisms must confirm that token transfers imply title transfer internationally.

• Global use invites scrutiny of the issuing authority or protocol. Trust in a CBDC reflects trust in the central bank's policy and governance. Protocol-level governance (especially in cryptocurrencies) raises questions about decision-making, especially in crises (e.g. smart contract bugs). Dispute resolution mechanisms, rollback protocols, or supervisory keys are being explored to balance trustlessness with accountability (Freiman, 2024). Multilateral arrangements – e.g. joint committees or voting frameworks – are emerging to address cross-border governance of multi-CBDC projects. Dispute resolution remains a challenge; in contrast to conventional systems, decentralised ledgers lack a clear recourse for reversing large erroneous transactions unless governance permits.

• Fragmented systems hinder cross-border transactions. Common standards and connectivity are essential to prevent siloed CBDCs. Projects like the mCBDC Bridge exemplify unified infrastructure, while bridge entities can

facilitate swaps between otherwise incompatible networks, though reintroducing intermediation (Bindseil et al., 2021). Proposals for a universal ledger or shared protocols (e.g. ISO 20022 messaging) support seamless data and payment flows. Additionally, ensuring FX liquidity – via atomic swaps or 24/7 exchange access – is vital for usability as a global digital currency. CBDCs must connect with pricing infrastructure and trading platforms globally, reinforcing their role as international units of account.

• The dimension of data and privacy is marked by conflicting national regimes: GDPR-style protections in the EU, surveillance-oriented frameworks in the US and China, and diverging data localisation rules. A globally used currency must meet all these simultaneously, prompting exploration of tiered privacy (e.g. anonymity for small payments, reporting for large ones) and advanced cryptographic techniques. Zero-knowledge proofs (ZKPs) allow validation of key conditions (e.g. whitelist status) without disclosing personal data. However, harmonising privacy thresholds across jurisdictions remains complex. Cybersecurity is critical: any international currency is a high-value target, and vulnerabilities – such as weak wallets in low-security regions – can compromise system trust. Thus, privacy, surveillance safeguards, and cyber-resilience must form part of enforceable cross-border institutional scaffolding.

In conclusion, the international viability of digital currencies hinges on a multilayered institutional framework. Beyond technological features, currencies must meet criteria for legal recognition, coordinated governance, interoperability, and privacy compliance. Only with such scaffolding can they ascend a digital monetary hierarchy.

Relational dynamics of the digital monetary hierarchy

Platform network effects and digital currency hierarchy. Network effects have long structured currency use: widespread acceptability attracts further adoption, entrenching a hierarchy with one or a few dominant units (notably the US dollar) (Cohen, 1998). Digitalisation is likely to intensify these dynamics as platform ecosystems – big-tech firms, e-commerce networks, social media, and super-apps – become arenas of currency competition and platform-driven internationalisation (O'Dwyer, 2023). Within this landscape, two designs loom: "walled-garden" platforms that issue quasi-currencies or tightly integrated payment tokens, and "open-bridge" platforms that interconnect multiple monies to foster interoperability. Meta's Libra/Diem illustrated the power of platform networks: a stablecoin plugged into billions of users could have attained near-instant international relevance, prompting regulatory pushback but revealing the concept's potency. Platform choices (e.g., a marketplace privileging the digital euro) can amplify digital network effects for selected currencies.

Walled-garden models may launch proprietary tokens or stablecoins (e.g., an "Amazon Coin" or hypothetical "Google token"), offering perks such as lower fees and deep service integration. Rapid user accumulation would remain largely inside the platform's closed loop, echoing historical private monies (company scrip, trade-network "currencies"). Multiple big-tech tokens would fragment the landscape, reduce interoperability (constant swapping), and effectively delegate "monetary policy" to platform rules – raising competition and regulatory concerns. Open-bridge designs instead enable low-friction, multi-currency transactions. A messaging app, for instance, could support person-to-person transfers in any major central bank digital currency (CBDC) or crypto, bridging via integrated exchanges or multi-currency wallets. Seamless conversion broadens acceptance: users become indifferent to the unit they hold. This can reinforce already-dominant currencies (deep liquidity, narrow spreads) yet also lower switching costs and support diversification. Bridge architecture – default-unit bias versus true currency agnosticism – will be decisive.

Composability and ecosystem building further entrench leadership. Decentralised finance (DeFi) protocols commonly use USD-pegged stablecoins as a unit of account, extending the dollar's primacy into crypto. Rival currencies must cultivate comparable application stacks; a digital yen or rupee could anchor regional fintech if policy and industry coordinate. First-mover advantage coexists with leapfrogging potential. Bitcoin's brand and developer base are hard to replicate, so newcomers piggyback on established rails (e.g., Ethereum). Incumbent fiat currencies enjoy similar inertia, yet a well-designed CBDC, tightly integrated with platforms, could outcompete correspondent-banking pipes via a step-change in cost and usability. A consortium of emerging-market central banks could, for regional trade, erode the dollar's edge if it delivers markedly easier settlement.

A digital monetary hierarchy will likely feature a few apex units: a digital dollar (stablecoin and/or future US CBDC), the digital euro, possibly a digital yuan if its network expands (Belt and Road linkages, integration with Alipay/WeChat), plus one or two borderless cryptocurrencies or stablecoins. Relative positions will hinge on:

• economic fundamentals – trust in currencies from strong, stable economies remains decisive; digitalisation alone cannot make an unstable or hyperinflationary unit attractive internationally;

• policy and institutional openness – low barriers for foreign use, transparent rules, and issuer support confer an advantage. The dollar benefits from the openness of U.S. financial markets; restrictive policies, such as ECB-imposed holding limits on non-residents, could weaken the euro's role despite technical sophistication;

• network access and partnerships – adoption by major platforms and global payment "kingmakers" (Visa, Mastercard, PayPal) shapes reach. Integration into such networks, especially with plug-and-play capability, accelerates uptake, as illustrated by Mastercard's CBDC interoperability pilots;

• path dependence and inertia – network effects can entrench incumbents, creating lock-in that resists change even when superior alternatives exist. Displacing the dollar requires achieving critical mass, offering compelling cost or efficiency gains, or triggering exogenous shocks – such as sanctions – that push countries toward non-dollar trade;

• government promotion and alliances – state-led initiatives or regional blocs may coordinate to boost mutual digital currency use, e.g., Belt and Road countries adopting e-CNY for settlements or Commonwealth members promoting each other's CBDCs (Cohen, 2018).

In the digital sphere, Metcalfe's law (network value scaling with the square of users) suggests powerful scale effects, but large open networks face congestion and governance constraints; reach may derive from interoperable ledgers rather than a single rail. Negative network effects also matter: systemic dominance can amplify shocks (e.g., dollar liquidity squeezes), and programmable-money failures would have outsized confidence impacts. Policymakers therefore have reasons to preserve diversity and redundancy – multiple corridors and currencies – to avoid single points of failure. In sum, digital connectivity magnifies winner-take-all tendencies, yet outcomes will be endogenously shaped by policy design, platform strategy, and technical architecture (Rey, 2015).

Programmable monetary sovereignty: new tools of control and influence. Digital money expands both the instruments of monetary sovereignty and the channels of external influence. Programmable monetary sovereignty denotes the use of code to enforce policy within a jurisdiction, potentially reshaping cross-border flows and currency hierarchies. Traditionally, sovereignty covers issuance, monetary policy, and capital controls. In digital form, these extend into transactions themselves via rule-based controls. A central bank digital currency (CBDC) can embed smart capital control: automated limits on outflows, approval gates for conversions, or crisis-time tightening activated algorithmically (Bindseil et al., 2021). Such designs place elements of the central bank and capital-control apparatus on "autopilot".

Externally, widespread foreign-currency use can import another state's policy. The United States already leverages the dollar's ubiquity and the reach of dollar-clearing networks to impose sanctions. In a fully digital setting, if Country A's CBDC or a stablecoin under A's jurisdiction dominates transactions in Country B, A could freeze addresses or apply negative interest on balances – creating programmable dependence. Adjustments to remuneration or fees function as seigniorage, potentially siphoning value from other countries' users, akin to an extraterritorial 'tax'. In effect, monetary policy is exported, underpinning concerns about digital dollarisation. On the functional continuum of money, a highly functional crypto-dollar stablecoin – stable, widely accepted, and liquid – can surpass the "moneyness" of a weak local unit. Welfare for users may improve, yet sovereignty erodes as influence shifts to the stablecoin's issuer and regulatory regime (presently, largely the US for dollar stablecoins). States can respond by (i) boosting the domestic currency's digital functionality, or (ii) regulating foreign digital usage. Measures include restricting or taxing specific foreign stablecoins, or co-opting the technology via a domestic CBDC with competitive features (e.g., privacy options, interest).

Programmability also augments fiscal capabilities. Algorithmic tax collection – for example, coding value-added tax (VAT) so the tax leg auto-remits at settlement – can raise compliance. Cross-border use, however, risks rule collisions (whose tax rules prevail), implying a need for international standards. Further, macro-prudential rules can be embedded in money or contracts (e.g., loans that adjust terms to policy rates or borrower risk). Such designs may act as automatic stabilisers or, if poorly specified, amplify stress. Supervisors will need to audit not only institutions but also the code, advancing regulation by code for cross-border stablecoins and CBDCs.

The intersection of platform and sovereignty dynamics is most visible in reserve currencies. Major issuers – the United States, the European Central Bank, and, to an extent, China – may seek to embed their currencies in global platforms and trade systems to lock in usage. China's e-CNY (digital yuan) could be integrated into the payment infrastructures of economies within its orbit, making yuan settlement easier than dollar settlement and thereby extending Chinese monetary influence. If transactions occur on Chinese servers or networks, China could, in practice, enforce Chinese financial regulations on those flows. Western counterparts may similarly encourage allies to rely on a hypothetical FedCoin or a Euro CBDC for convenience, consolidating their spheres of influence. The analogy with SWIFT and CHIPS (the US-centric bank messaging/settlement networks) holds, but digital money implies tighter integration because the currency layer, not just the messaging layer, is now at stake. This creates programmable dependence and raises the stakes of currency internationalisation.

There is also a geopolitical risk of programmable dependence on foreign technology. If a state adopts an off-the-shelf CBDC platform from a major central bank or a global technology firm, it may inadvertently allow backdoor control or surveillance. Several smaller jurisdictions – such as some Caribbean states – have relied on overseas vendors and thus had to trust foreign code for core monetary functions. In an era of great-power rivalry, the offer or denial of such technology becomes a tool of influence. Consequently, while digital money equips governments with new internal instruments of monetary sovereignty and programmable control, it simultaneously heightens exposure to external policy importation. If a foreign digital currency becomes prevalent domestically, that foreign power's policy – and even its glitches – enter the local policy landscape de facto. A tug-of-war is therefore likely: states seek the gains from integration in trade and investment while guarding autonomy. Plausible safeguards include kill-switches to ring-fence or freeze foreign currency flows swiftly, and negotiated limits – for example, agreements that one central bank will not apply specified rules to users in the other's jurisdiction without consent. Therefore, three brief case studies ground the analysis:

1. China's e-CNY exemplifies a large economy's retail CBDC with international ambitions. Its two-tier design and controllable anonymity, rapid domestic uptake in pilot regions, and cross-border trials (e.g., the Hong Kong bridge) show how a major state can use digital currency for both domestic efficiency and strategic positioning. China can piggyback on Alipay and WeChat to accelerate adoption, has adjusted laws to enable issuance, and is negotiating interoperability in Bank for International Settlements (BIS) pilots.

2. JPMorgan's Onyx platform and JPM Coin illustrate a private, wholesale model. JPM Coin, a permissioned interbank token used among corporate and institutional clients, delivers instant cross-border settlement within a governed network. The case highlights single-entity governance, emerging interoperability with other banks and even central banks in trials, and the need for regulatory comfort (Ledger Insights, 2025). It also shows how a walled-garden network can scale if deposit tokens become interoperable, thereby complementing – or competing with – public money.

3. Nigeria's eNaira – Africa's first CBDC – demonstrates the limits of technology without strong demand and institutional alignment. Despite goals of inclusion and reduced cash usage, adoption after more than a year remained under one per cent, reflecting limited merchant acceptance, an initially banked-only rollout, and weak use-cases relative to cash and existing mobile money (Ree, 2023). Its functional moneyness remains low: it is legal tender but not widely accepted as a medium of exchange and not trusted as a superior store of value in a context of inflation. Institutional reluctance – reportedly including banks wary of deposit substitution – further impeded uptake, and the eNaira has no international role to date.

Comparing these cases reveals consistent patterns. User trust and network size are decisive; clarity of purpose matters. China can mandate and market e-CNY (e.g., enabling salaries and transit payments), JPMorgan leverages existing client trust to drive wholesale adoption, and Nigeria, lacking compelling user benefits and full stakeholder alignment, struggled to reach critical mass. In each instance, the balance between integration and sovereign control remains the central policy trade-off.

ISSN 1728-3817

Discussion and conclusions

From domestic token to international unit: new thresholds and alliances. A digital currency can progress from a local medium to a bona fide international currency only by meeting a set of threshold conditions across technical, legal-policy, network, and trust-stability dimensions. Digitalisation may accelerate certain steps, but it raises the bar for others:

• technical thresholds require 24/7 resilience and scalability. International markets operate continuously, so an aspiring global unit must remain reliably available and capable of handling high volumes at all times. Planned maintenance windows, recurrent congestion, or extended outages are incompatible with global commerce. Even sophisticated systems – such as TARGET2, the euro interbank system – have experienced interruptions, underscoring the need for redundancy across time zones and failover architectures. Cybersecurity is integral to resilience: a widely used network will face persistent attack, making investment in advanced, even quantum-resistant cryptography, essential. Any successful exploit or double-spend would disproportionately damage international confidence. The uncompromising technical bar is robust, with continuous operation at scale.

• legal and policy thresholds turn on extraterritorial recognition or acceptance. Formal legal-tender status abroad is rarely necessary; what matters is that foreign courts, regulators, and financial institutions permit use, recognise finality, and clarify the legal nature of holdings (for example, whether digital balances are deposits or cash equivalents). Pathways include statutory amendments that recognise e-money or crypto-assets for defined purposes, bilateral memoranda of understanding between central banks on cross-border CBDC use and settlement finality, and, ultimately, a treaty or multilateral framework analogous to aspects of the IMF's Articles of Agreement. Equally, capital account openness is decisive: convertibility and liquidity access are legal/policy thresholds. If entry and exit are constrained by quotas or approvals, foreign usage will remain limited, even if the technology is sound.

• network thresholds reflect tipping points where usage becomes self-reinforcing. Coordinated adoption by a trade bloc such as ASEAN or MERCOSUR, interlinking CBDCs, or an alliance of convenience around a common settlement coin (for example, a BRICS digital unit or a regional stablecoin) can create rapid regional lock-in and de facto acceptance. A parallel requirement is financial market integration. To function as a true international currency, the unit must anchor investment at scale – through accessible bond markets, CBDC-compatible securities and accounts, and interoperability with global custodians and trading platforms – so that central banks and funds can hold it as a store of value, not merely use it as a payment rail.

• trust and stability thresholds remain foundational. No currency can internationalise without credible macroeconomic governance, low and predictable inflation, and policy coherence. Digital features may enhance stabilisation via richer data and rule-based operations, yet they can also amplify stress – for example, by enabling app-speed runs. The issuer must demonstrate a consistent track record under real conditions; early missteps or heavy-handed interventions (such as arbitrary freezes) would deter foreign uptake.

In sum, internationalisation requires a domestic token to pass a conjuncture of thresholds: uncompromising technical resilience, clear extraterritorial recognition, practical convertibility with ample liquidity access, dense network alliances and market linkages, and sustained trust and stability. Digitalisation may lower frictions to foreign use, but it simultaneously elevates the technical and legal standards a currency must satisfy to attain durable international status.

Opportunities for peripheral currencies: leapfrogging and risks of dependence. For peripheral currencies – units little used beyond their home jurisdictions – the digital transition presents both opportunity and risk. The "leapfrogging" hypothesis holds that smaller economies can adopt advanced designs rapidly and bypass traditional choke points, notably the correspondent banking network, to secure niche international roles. The countervailing risk is programmable dependence: reliance on digital infrastructures controlled by core-currency states or large private providers can deepen subordination to incumbent monetary powers. Promising avenues for leapfrogging are clear:

• cross-border payments and remittances remain costly and slow; a well-engineered digital remittance corridor can attract diaspora usage and regional partners. Initiatives such as the Eastern Caribbean Central Bank's DCash and Nigeria's eNaira explicitly target fee reduction and speed. Success would not confer reserve-currency status, but it could entrench regional relevance, strengthen own-currency demand in specific flows, and reduce dependence on intermediary dollars;

• regional integration can amplify these gains: interlinked CBDCs (central bank digital currencies) within groupings such as the African Union or ECOWAS could make local-currency payments across borders as seamless as dollar settlement, replicating, in technological rather than legal form, the pooling benefits that the euro delivered in Europe;

• targeted use-cases offer further scope. A commodity-backed digital currency – redeemable in an exported staple or tied to mineral wealth – could attract foreign investors seeking commodity exposure without logistical frictions. Alternatively, a jurisdiction with a particularly stable, well-governed CBDC could position itself as a digital safe haven, offering non-resident accounts with strong privacy and asset-protection features.

Leapfrogging is not automatic. The eNaira illustrates that a CBDC does not guarantee adoption absent institutional trust, macroeconomic stability, merchant acceptance, and compelling use-cases relative to cash or existing mobile money. International constraints also matter. Designs that court illicit flows – such as extreme privacy – may trigger pressure from major powers, including sanctions or network exclusion. While the BIS and IMF encourage CBDC experimentation, such support is conditional on objectives like inclusion and efficiency rather than secrecy.

The structural risks are equally salient. Outsourcing to off-the-shelf CBDC platforms – as with DCash's vendor Bitt – can import backdoor control or surveillance risks and expose core monetary functions to foreign code. More directly, allowing foreign stablecoins to dominate – imagine widespread domestic use of USDC (a United States-regulated stablecoin) rather than the local unit – extends extraterritorial visibility and control, including the power to freeze tokens, and intensifies digital dollarisation. A broader hazard is digital currency colonialism, whereby big states or big tech provide turnkey monetary rails that lock in smaller economies to external ecosystems. The reaction to Facebook's Libra – which many perceived as such a threat – accelerated CBDC programmes across emerging markets; similar dynamics could accompany e-CNY expansion

along Belt and Road channels or the growth of United States-centric stablecoin networks. Mitigation requires negotiated safeguards – treaties on governance representation, data-sharing limits, and non-discrimination – or risk targeted, programmable pressure (for example, selectively filtering or taxing transactions on a foreign CBDC network).

Peripheral states, therefore, face a strategic choice. They can invest in domestic digital monetary infrastructure, often with regional coalitions, to enhance utility and autonomy, or they can adopt foreign digital currencies and accept a subordinated role. Hybrid strategies are plausible: a country might rely on a foreign digital unit for remittances while promoting its own CBDC for domestic retail and regional trade; smart wallets can hold multiple CBDCs and route by context. Digital money is unlikely to overturn monetary hierarchies overnight – economic fundamentals remain decisive – but it can enable modest reordering. The most plausible outcome is multipolar usage: the dollar, euro, and yuan building digital zones of influence, with other currencies aligning to one of these zones or developing regional coalitions to avoid marginalisation. In this environment, digital diplomacy by major powers and careful policy design by smaller states will determine whether leapfrogging delivers autonomy or slides into renewed programmable dependence.

Synthesis and research agenda. This article examines how digitising money – encoding currency as software – reconfigures its ontology and identifies the institutional prerequisites for digital units to attain international status. The inquiry spans theoretical redefinitions, technological architectures, legal and governance conditions, and the strategic dynamics of network effects and sovereignty. The following synthesis preserves the argument's substance and sets a forward-looking research agenda.

Digitisation re-ontologises money by making it programmable and composable, collapsing the boundary between the object of value and the transfer system. Distributed ledgers instantiate decentralised collective intentionality, allowing social trust to be engineered through protocols rather than solely through state authority or traditional intermediaries. This supports a continuum view of moneyness: a digital asset that is collectively accepted and performs money's functions can operate as money irrespective of its formal designation. We propose a functional metric of moneyness – a three-dimensional space (means of exchange, unit of account, store of value) whose parallelepiped volume yields a composite score. A cryptocurrency that matches or exceeds a weak sovereign currency on this metric warrants recognition as money in practice. Future work should construct quantifiable indices of moneyness (e.g., liquidity, volatility, breadth of acceptance) and test whether functional volume correlates with observed usage.

International scaling requires coordinated thresholds across law, governance, interoperability, privacy-security, and network readiness:

• Legal and regulatory conditions demand extraterritorial recognition, enforceability of contracts, protected finality, and compliance with international norms. Comparative legal analysis of Eurodollars and the ECU can inform digital design, as can early CBDC (central bank digital currency) reforms in the Bahamas, the Eastern Caribbean, and Nigeria.

• Governance must be predictable and contestable. Multi-country or multi-stakeholder models – such as mCBDC arrangements – merit evaluation, including a hypothetical "Digital IMF Coin".

• Interoperability requires common standards and linkages. Priority areas include ISO 20022 adoption in CBDCs and the assessment of SWIFT CBDC linking trials.

• Privacy and security must balance confidentiality with compliance. Zero-knowledge proofs and auditable-privacy designs should be tested in regulatory sandboxes to gauge trust and supervisory comfort.

• Network readiness calls for formal diffusion models and agent heterogeneity. Network-science simulations should evaluate the catalytic role of multinational firms that invoice or settle exclusively in a digital euro or yuan.

Digitalisation reconfigures processes but is likely to reinforce core hierarchies (USD, EUR, CNY) even as it opens niches for new entrants and coalitions. Incumbents possess the scale, institutions, and geopolitical reach to internationalise robust digital versions. Smaller currencies can leverage niches or pool infrastructure, yet a new, unbacked cryptocurrency is unlikely to displace incumbents absent severe mismanagement by the latter. A neutral, decentralised unit could gain traction under crisis conditions, although current evidence – such as Bitcoin's volatility and limited trade use – suggests this outcome is improbable without a truly global stablecoin not tethered to a single state's policy.

International bodies (IMF, BIS) should coordinate standards to ensure the safe coexistence of digital currencies. Smaller states need capacity-building to shape norms rather than accept externally imposed architectures. Public-private cooperation is essential: regulated stablecoins atop CBDC rails – a synthetic-CBDC model – could harness innovation while preserving sovereign control. Priority lines include: (i) macroeconomic effects of CBDC adoption on bank intermediation, interest rates, and capital flows; (ii) user behaviour and trust drivers in digital choice architectures; (iii) robust cross-ledger interoperability with formal verification to mitigate bridge risk; (iv) environmental impacts and the regulatory salience of energy-efficient consensus; and (v) geopolitical strategies and "digital diplomacy," including potential Bretton Woods 2.0 for currency standards.

Tokenised value and programmable money are reshaping monetary relations and patterns of currency use. Money's ontology – the social conditions under which tokens acquire moneyness – has immediate policy relevance as code and law co-produce monetary reality. Agile domestic and international governance is required to encode shared values – privacy, stability, sovereignty, and innovation – into the new infrastructure. Digital currency internationalisation will be a co-evolution of technology and institutions, and the next decade's pilots and platform integrations will provide the evidence base to refine these models.

Authors' contribution: Serhii Tsyhanov – materials preparation, technical support, and advisory input. Andrii Buz – materials preparation, conceptualisation and study design, methodology, drafting, and critical revision of the manuscript.

Sources of funding. This study received no grant from any funding agency in the public, commercial, or not-for-profit sectors.

References

Aneja, R., & Dygas, R. (Eds.). (2024). *Digital currencies in the new global world order*. Palgrave Macmillan. https://doi.org/10.1007/978-981-97-4810-5

Ashfaq, M., Hasan, R., & Merčon, J. (2023). *Central bank digital currencies and the global financial system: Theory and practice*. De Gruyter. https://doi.org/10.1515/9783110982398

Skingsley, S. (2021). (Interv.) *Central bank digital currencies for cross-border payments: Report to the G20*. BIS. https://www.bis.org/ publ/othp38.htm

Bank for International Settlements. (2022). *III. The future monetary system*. In *BIS annual economic report 2022*. BIS. https://www.bis.org/publ/ arpdf/ar2022e3.htm

Bhatia, N. (2021). *Layered money: From gold and dollars to Bitcoin and central bank digital currencies*. Open Atelier.

Bindseil, U., Panetta, F., & Terol, I. (2021). *Central bank digital currency: Functional scope, pricing and controls* (Occasional Paper No. 286). European Central Bank. https://dx.doi.org/10.2139/ssrn.3975939

Caton, J. (2020). *Status functions, speech acts, and the emergence of money* (AIER Working Paper 2019-15, rev. 2020). American Institute for Economic Research. https://dx.doi.org/10.2139/ssrn.3445569

Cohen, B. J. (1998). *The geography of money*. Cornell University Press.

Cohen, B. J. (2018). *Currency statecraft: Monetary rivalry and geopolitical ambition*. University of Chicago Press. https://doi.org/10.7208/chicago/9780226587868.001.0001

Desan, C. (2014). *Making money: Coin, currency, and the coming of capitalism*. Oxford University Press. https://doi.org/10.1093/acprof:oso/9780198709572.001.0001

Eichengreen, B., & Viswanath-Natraj, G. (2022). Stablecoins and central bank digital currencies: Policy and regulatory challenges. *Asian Economic Papers,* 21(1), 29–46. https://doi.org/10.1162/asep_a_00843

Financial Stability Board, & International Monetary Fund. (2024, October 22). *G20 crypto-asset policy implementation roadmap: Status report*. FSB. https://www.fsb.org/uploads/P221024-3.pdf

Freiman, O. (2024, September 1). *CBDC governance: Programmability, privacy and policies*. CIGI Digital Policy Hub Working Paper. https://dx.doi.org/10.2139/ssrn.5118025

Halaburda, H., Haeringer, G., & Sarvary, M. (2022). *Beyond Bitcoin: Economics of digital currencies and blockchain technologies* (2nd ed.). Springer. https://doi.org/10.1007/978-3-030-88931-9

Ikpeazu, U. C. (2023). *Philosophy of digital currencies: A theory of monetising ontology* (1st ed.). Routledge. https://doi.org/10.4324/9781003330417

Ingves, S., Julin, E., Lindskog, S., Söderberg, G., & Vestin, D. (2022). What is money and what is the role of the state in the payments market? *Sveriges Riksbank Economic Review,* (2), 6–39. Sveriges Riksbank. https://www.riksbank.se/globalassets/media/rapporter/pov/artiklar/engelska/2022/221216/2022_2-what-is-money-and-what-is-the-role-of-the-state-in-the-payments-market.pdf

Ingham, G. (2004). *The nature of money*. Polity Press.

Knapp, G. F. (1924). *The state theory of money* (H. M. Lucas, & J. Bonar, Transl.). Macmillan.

Larue, L. (2024). John Searle's ontology of money, and its critics. In J. Tinguely (Ed.), *The Palgrave handbook of philosophy and money:* Vol. 2: *Modern thought* (pp. 721–741). Palgrave Macmillan. https://doi.org/10.1007/978-3-031-54140-7_36

Ledger Insights. (2025, August 6). *Clearing firm Marex adopts JPM's Kinexys Digital with Brevan Howard.* Ledger Insights. https://www.ledgerinsights.com/clearing-firm-marex-adopts-jpms-kinexys-digital-with-brevan-howard/

Leucci, S., Attoresi, M., & Lareo, X. (2023, March 29). *TechDispatch #1/2023: Central bank digital currency*. European Data Protection Supervisor. https://www.edps.europa.eu/data-protection/our-work/publications/techdispatch/2023-03-29-techdispatch-12023-central-bank-digital-currency_en

Lloyd, M. (2023). *Central bank digital currencies: The future of money*. Agenda Publishing. https://doi.org/10.1017/9781788216333

Nicolini, G., & Intini, S. (2023). *The cryptocurrency phenomenon: The origins, evolution and economics of digital currencies*. Routledge. https://doi.org/10.4324/9781003353102

Nili, C., Patterson, T., & Dukatz, C. (2024). *Safeguarding central bank digital currency systems in the post-quantum computing age*. World Economic Forum. https://www.weforum.org/stories/2024/05/safeguarding-central-bank-digital-currency-systems-post-quantum-age/

O'Dwyer, R. (2023). *Tokens: The future of money in the age of the platform*. Verso.

Ree, J. (2023). *Nigeria's eNaira, one year after (IMF Working Paper No. 2023/104).* International Monetary Fund. https://doi.org/10.5089/9798400241642.001

Rey, H. (2015). Dilemma not trilemma: The global financial cycle and monetary policy independence. In *NBER macroeconomics annual* (Vol. 29, pp. 285–333). University of Chicago Press. https://www.kansascityfed.org/Jackson%20Hole/documents/4575/2013Rey.pdf

Searle, J. R. (1995). *The construction of social reality*. Free Press.

Yermack, D. (2015). Is Bitcoin a real currency? An economic appraisal. In D. Lee (Ed.), *The handbook of digital currency* (pp. 31–43). Elsevier. https://doi.org/10.1016/B978-0-12-802117-0.00002-3

Отримано редакцією журналу / Received: 10.09.25
Прорецензовано / Revised: 23.09.25
Схвалено до друку / Accepted: 23.12.25

Сергій ЦИГАНОВ, д-р екон. наук, проф.
ORCID ID: 0000-0002-9032-7829
e-mail: S_Tsyganov@knu.ua
Київський національний університет імені Тараса Шевченка, Київ, Україна

Андрій БУЗ, асп., асист.
ORCID ID: 0000-0003-0074-0693
e-mail: andrii_buz@knu.ua
Київський національний університет імені Тараса Шевченка, Київ, Україна

ЦИФРОВЕ ПЕРЕОСМИСЛЕННЯ ОНТОЛОГІЇ ГРОШЕЙ: ІНСТИТУЦІЙНІ ПЕРЕДУМОВИ ВАЛЮТНОЇ ІНТЕРНАЦІОНАЛІЗАЦІЇ В ЕПОХУ ТОКЕНІЗОВАНОЇ ВАРТОСТІ

Вступ. ***Поява цифрових валют центральних банків і криптовалют – форм грошей, реалізованих у вигляді коду – зумовила фундаментальне переосмислення онтології грошей. Класична теорія розрізняє онтичний статус грошей (що таке гроші) та їхні онтологічні умови (як вони набувають суспільного визнання як гроші). Токенізація порушує цю дихотомію, вбудовуючи монетарні функції у програмовані цифрові архітектури. У цьому дослідженні аналізується, як поява токенізованої вартості та програмованих грошей спонукає до переоцінки буття грошей, з особливим акцентом на їхній вплив на інтернаціоналізацію валют.***

Методи. ***Стаття ґрунтується на якісному змішаному підході, що поєднує теоретичне моделювання та порівняльний аналіз кейсів. Розроблено концептуальну модель(функціональний континуум "грошовості") із застосуванням тривимірної метрики, побудованої на основі класичних функцій грошей. Документальний аналіз монетарної теорії та міжнародної практики підтримує цю модель, а порівняльні тематичні кейси (зокрема, e-CNY, Onyx, e-Naira) ілюструють інституційну плюральність.***

Результати. ***Отримані результати свідчать, що токенізація нівелює традиційну відмінність між грошовим знаком і платіжною інфраструктурою, роблячи трансферентність вбудованою функцією цифрових грошей. Смартконтракти та виконання правил на рівні протоколу забезпечують автономну реалізацію монетарних норм – явище, окреслене тут як "програмована суверенність". Представлено типологію реєстрових архітектур – від бездозвільних публічних блокчейнів до облікових державних систем – кожна з яких має специфічні наслідки для довіри, композиційності та транскордонного охоплення. Інституційні передумови міжнародного обігу проаналізовано за правовим, управлінським, інтероперабельним та конфіденційним вимірами. Ключовим є сформульоване гіпотетичне положення: криптовалюта, яка функціонально відповідає або перевищує рівень "грошовості" найслабшої визнаної фіатної валюти, може вважатися грошима у глобальному вимірі незалежно від державного схвалення.***

Висновки. ***Цифровізація перетворює гроші на програмований інституційний об'єкт, розширюючи онтологічний спектр того, що може визнаватися валютою. Водночас потенціал досягнення міжнародного масштабу залежить від здатності цифрових токенів задовольнити ключові інституційні критерії: юридичне визнання або толерування за кордоном, надійне управління, технологічна інтероперабельність і збалансованість між захистом приватності та регуляторною відповідністю. Запропонована модель забезпечує теоретичну основу й тестовані положення для оцінки траєкторій інтернаціоналізації цифрових грошей, зокрема їхнього потенціалу або обходити, або інтегруватися у чинні ієрархії світової валютно-фінансової системи.***

Ключові слова: ***монетарна онтологія; токенізована вартість; валютна інтернаціоналізація; міжнародна макроекономіка; криптовалюти; цифрові фінанси; цифрова валюта центрального банку; програмовані гроші; міжнародна валютно-фінансова система; міжнародна фінансова архітектура; фінансова стабільність; економічна інтеграція; макроекономічна політика.***

Автори заявляють про відсутність конфлікту інтересів. Спонсори не брали участі в розробленні дослідження; у зборі, аналізі чи інтерпретації даних; у написанні рукопису; в рішенні про публікацію результатів.

The authors declare no conflicts of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

ISSN 1728-2292 (Print)