The Roles of Physical Money in the Era of Digitalization

Domagoj Sajter
Full Professor at Faculty of Economics in Osijek, Croatia
e-mail: sajter@efos.hr, phone: +385 91 2244 102; web: https://www.efos.unios.hr/nastavnici/domagoj-sajter/

Abstract

This paper examines how the expansion of digital money reshapes (rather than eliminates) the role of physical cash in the monetary system. Building on the view that money is an institutional arrangement, it develops a comparative framework that distinguishes public physical money (coins and banknotes), public digital money (central-bank liabilities in digital form, including wholesale reserves and prospective retail CBDC initiatives such as the digital euro), and private digital money (commercial-bank deposits, platform-mediated payment infrastructures, and fiat-referenced stablecoins). The analysis compares these forms across four core properties: issuer and liability structure, governance of the ledger and access rules, settlement finality, and the allocation of credit, liquidity, operational/cyber, and legal risks. The paper argues that cash remains institutionally different from digital instruments, which can replicate some of the functions of cash, but only through design choices. These choices introduce new dependencies on infrastructure, intermediaries, and governance rules, turning privacy and access into explicit policy parameters. The resulting "multi-money" ecosystem raises a policy question that is not whether cash can be replaced technologically, but which combinations of monetary roles society wishes to preserve, and under which precautions for resilience, inclusion, and monetary sovereignty.

Keywords

cash; digitalisation; payment systems; CBDC; digital euro; payment platforms; privacy; stablecoins

JEL Codes

E41; E42; E58; G21; G28; O33

1. Introduction

When reflecting on different forms of money in the context of rapid digital transformation, the prevailing narrative over past decades has been the "inevitable" shift towards fully cashless society (Stearns, 2011; Wolman, 2012; Bátiz-Lazo et al., 2014; Weisman-Pitts, 2025, etc.). Curators of public good (i. e. cash) mostly stood aside as profit-driven interests from private corporations denigrated cash as anachronistic, filthy carrier of diseases, used by criminals and terrorists, implying that clean and virtuous citizens should avoid it (Scott, 2016).

However, after major global disruptions, namely COVID-19 pandemics, the war in Ukraine, supply chain disturbances, destabilization of world order and rapidly rising geopolitical and cyber risks, calls for cash demand and protection policies have resurfaced (Norges Bank, 2023; ECB, 2025; De Nederlandsche Bank, 2025). As the sole physical currency, cash is the only alternative to everything set out to perform as "digital money". Only coins and banknotes can enable all of the following roles and functions:

a) intermediary-free exchange (bearer possession without ledger operators or any other third party),
b) infrastructure-free operability (without internet, electricity or battery operated devices),
c) immediate finality and settlement (no post-transaction processes),
d) anonymity and privacy in holdings and transactions,
e) informality (permissionless participation, no gatekeepers, foundation of informal economy (see ILO, 2026)),
f) behavioural aspects (tangibility and non-abstractness).

Obviously, these are interconnected and stem from each other. While digital money (notably crypto-assets) can mimic cash in some of them, digitalisation inevitably amputates certain essential roles of money.

Recognizing the irreplaceability of cash (Sajter, 2013) while also acknowledging the global shift toward a digital economy and the need for the coexistence of traditional and modern forms of money, this paper aims to answer the following question: how does digital money reshape the place of cash in the monetary system? In an attempt to answer this, the "universe of digital monies" could be broadly separated in two major categories:

1) public digital money (central bank digital currencies – CBDCs, with the digital euro) and
2) private digital money (commercial-bank money, card-network infrastructures, stablecoins).

This paper contributes to the existing literature by defining essential characteristics of public and private digital money, how they are related, and what specific roles they can serve in comparison to physical money. This is important because policy debates and regulatory choices increasingly treat cash as a residual or transitional instrument, while overlooking the fact that different forms of money are not merely technological substitutes but institutional arrangements with distinct economic, social, and political functions, whose erosion or preservation has direct implications for monetary sovereignty, financial inclusion, systemic resilience, and the balance of power between public authorities and private infrastructures.

Methodologically, the paper is conceptual and synthetic. It draws on selected contributions from monetary theory, payment-system economics, and the emerging CBDC literature to develop a comparative framework based on issuer/liability structure, ledger governance and access rules, settlement finality, and risk allocation, with the purpose to clarify trade-offs and policy-relevant peculiarities rather than to provide new quantitative estimates.

The paper is structured as follows. The next section reviews selected literature on cash substitution, payment platforms, and the informational functions of money. The subsequent section develops the paper's comparative framework and distinguishes public and private digital money in relation to physical cash. The discussion section evaluates how each form performs key monetary roles before the paper concludes with implications, limitations, and directions for further research.

2. Literature review

This section presents selected studies significant to the purpose and scope of this paper, ordered by their influence and impact which is measured by the number of citations of each study.

The foundational empirical analysis of the substitution between cash and electronic payment methods can be found at Humphrey et al. (1996), which is relevant to this paper because it provides an early and rigorous cross-country analysis of the substitution between cash, paper-based, and electronic payment instruments. Its key contribution lies in showing that the decline of cash is not driven primarily by technological progress over time, but by persistent institutional and structural differences across countries. By distinguishing between paper-based and electronic non-cash payments, the authors also demonstrate that "non-cash" money is not a uniform category and that different instruments interact with cash in distinct ways. This is valuable for understanding why cash continues to perform specific roles that are not fully displaced by digital alternatives.

Bátiz-Lazo et al. (2014) explain the historical and sociological shift toward digital money. They demonstrate that the idea of a cashless society is not a recent technological consequence, but a recurring policy and business narrative shaped by expectations and vested interests over several decades. By showing how visions of a world without cash repeatedly failed to materialise despite advances in payment technologies, the authors provide a critical historical perspective.

Rochet & Tirole (2003) present the seminal work for understanding "private digital money" (card networks) as two-sided platforms with gatekeepers, and provide the foundational analytical framework for understanding payment systems and digital money. By showing that price structure, governance, and network externalities fundamentally shape outcomes in payment systems, they help explain why private digital payment infrastructures differ from cash. This insight is important for analysing how digital money reshapes, but does not replicate the roles performed by physical cash.

Providing "memory" and anonymity are significant functions of physical money (Kocherlakota, 1998; Kahn et al., 2005). They are closely connected because they both analyse money as an informational institution, but emphasise different functions that are essential to this paper. Kocherlakota conceptualises money as a substitute for record-keeping, showing that money economises on information and enforcement by replacing memory. Kahn et al. demonstrate that even when record-keeping is technologically feasible and low-cost, money retains an essential role by providing privacy and anonymity. These papers explain that cash is not just a transitional invention surpassed by digitalisation, but an institutional arrangement whose physical form supports its functions.

Regarding the different types of digital monies and the coexistence of CBDC (public) and private infrastructures, Andolfatto (2021) examines how public digital money interacts with and potentially disrupts private banking sectors. He shows that the introduction of CBDC does not replace bank lending or destabilise the financial system, and that cash and deposits can coexist with public digital money, which supports the argument that digitalisation reshapes monetary roles without making physical money obsolete. On the other

hand, Agur et al. (2022) analyze the optimal design of "public digital money" (CBDC) and its competition with cash and bank deposits. Their model demonstrates that cash could disappear if digital public money is poorly designed, thereby emphasising the irreplaceability and policy relevance of physical money. Introducing a central bank digital currency affects welfare by trading off more efficient payments against bank disintermediation, showing that digital money reshapes the monetary system through design-dependent trade-offs rather than simple substitution, hence demonstrating that cash holds institutionally distinct roles even in a digitalised environment (Keister & Sanches, 2023).

Brunnermeier and Niepelt (2019) directly address the question on the relationship and equivalence between private and public forms of digital money. They give a theoretical benchmark showing the conditions under which public and private money can be equivalent in equilibrium. By explicitly identifying when such equivalence breaks down (through liquidity, wealth, or institutional non-neutralities) the paper offers a conceptual framework that clarifies why cash and digital money cannot be treated as technological substitutes.

Within literature there is a coherent arc from viewing money and payments as cost-minimising technologies to understanding them as institutional arrangements shaped by information, incentives, and network structures (Kahn & Roberds, 1998; Humphrey et al., 2001; Rysman, 2007; Klee, 2008; Arango et al., 2015; Ching & Hayashi, 2010). Early contributions analyse substitution between cash and electronic payments through efficiency, pricing, and cost considerations, while later work shows that payment systems operate as platforms with network effects, strategic pricing, and settlement risks that fundamentally alter behaviour. This collectively shows that digitalisation transforms the monetary system not by simply replacing cash, but by reconfiguring the roles of money, the distribution of power between public and private actors, and the trade-offs between efficiency, resilience, privacy, and control.

Taken together, this literature implies that the relevant comparison is not "cash versus digital" as a purely technological choice, but a set of institutional arrangements that differ in issuer, access rules, settlement properties, and risk allocation. The next section builds on this insight by formalising these properties and using them to distinguish public from private digital money alongside physical cash.

3. Overview of the central principles of digital money

This section distinguishes two broad categories of digital money: public digital money (central bank digital currencies, including initiatives such as "digital euro") and private digital money (commercial-bank money, card-network infrastructures, and stablecoins), and clarifies how they relate to each other and to physical cash.

A useful way to organise the universe of digital monies is to treat each category as a group of design properties rather than as a substitute technology for cash. From an economic perspective these categories are not just "technological formats" of the same object, but they are different institutional arrangements defined by the following properties:

1) the issuer of the liability,
2) the governance of the ledger and access rules,
3) the nature of settlement finality, and
4) the allocation of risks (credit risk, liquidity risk, operational/cyber risk, and legal/regulatory risk).

These properties determine whether a digital instrument behaves like central bank money (ultimate settlement asset), like a layered claim on intermediaries (commercial bank money and most payment platforms), or like a privately issued promise to maintain parity with sovereign currency (stablecoins). Furthermore, they are connected with the economic and social roles emphasised in the introduction of this paper; intermediary-free exchange, infrastructure-free operability, and anonymity are not "features" that can be added or removed without trade-offs, they are outcomes of whether the monetary instrument is bearer-based or ledger-based, and of who is permitted to run and access the validation infrastructure. Digital money can improve convenience, speed, and integration with online commerce, and it can lower some transaction costs, but it increases reliance on intermediaries thereby changing the balance between efficiency and autonomy, and between private platform power and public monetary sovereignty.

Therefore, "digital money" is not a single instrument but a cluster of monetary arrangements whose common denominator is that ownership and transfer are represented and validated in digital records rather than by physical bearer possession. This seemingly technical observation has important consequences. With cash value is embodied in the object itself and transfer is completed by handing it over. With digital money value exists as an entry on a ledger (or a set of linked ledgers), which means that the ability to pay is inseparable from

the rules of access to the ledger, the entity that operates it, and the procedures that validate and settle transactions. In other words, digitalisation does not simply change the "format" of money; it relocates money's core functions into an infrastructure layer that can be governed publicly or privately and which represents choices about control, privacy, pricing, and resilience.

For analytical clarity in the rest of this paper the digital ecosystem is divided into two ideal types: public digital money and private digital money, while recognising that many real-world designs are not in the extremes but are positioned on a continuum. Public digital money includes central-bank liabilities in digital form (today mainly reserves for wholesale users, and potentially CBDC for the general public). Private digital money includes commercial-bank deposits and the payment platforms built on top of them (card networks, mobile wallets, payment processors), as well as tokenised forms such as stablecoins. The next two subchapters define these categories and highlight the mechanisms through which they differ from one another and from physical cash, which prepares the ground for the subsequent discussion of how each form performs (or fails to perform) the roles traditionally associated with money.

3.1. Public digital money

In the context of this paper "public digital money" denotes a digital monetary instrument that is ultimately a liability of the central bank and therefore represents the public monetary anchor in the same unit of account as cash, even though it is implemented through ledger-based infrastructure rather than bearer possession.

The first defining property is the issuer of the liability. Unlike deposits, stablecoins, or card-network balances, public digital money is issued by (and is a direct claim on) the central bank, which makes it the highest credit quality form of domestic money. The second property is governance of the ledger and access rules: because value is represented and validated in records, public digital money necessarily entails explicit rules about who can hold it, how identity and transactions are handled, and whether the architecture is "direct" (central bank closer to end users) or intermediated (private actors provide wallets and customer-oriented services while the central bank holds the claim). The third is the nature of settlement finality. Transfers of public digital money can be designed to achieve final settlement in central bank money at the point of transaction (such as in digital euro), which is conceptually closest to the immediacy of cash (even if finality still depends on the integrity and availability of the digital system). The fourth property is risk allocation. Public digital money largely removes private-issuer credit risk from the end user, but it does not remove risk entirely. Instead it shifts the main vulnerabilities toward operational and cyber risk, policy and governance risk (including privacy rules), while legal/regulatory risk is tied to how the instrument is defined, supervised, and integrated with existing payment systems.

Examples of public digital money include wholesale central-bank reserves (the existing form of digital central bank money used for interbank settlement), retail-oriented initiatives such as the digital euro project, and CBDCs in preparation, issued or piloted in various jurisdictions (for example, the Bahamian Sand Dollar, Nigeria's eNaira, Jamaica's Jam-Dex, and China's Digital renminbi).

While the "digital euro" and CBDC might seem as synonyms, it is important to distinguish between them. Digital euro is the Eurosystem's label for a specific CBDC proposal for the euro area. CBDC is a generic concept: a digital payment instrument in the national unit of account that is a direct liability of a central bank, distinct from traditional reserve/settlement accounts. Hence, CBDC leaves a wide space for design options, while the digital euro focuses on a particular set of objectives, governance constraints, and implementation choices for one currency union. The ECB frames the digital euro as a "digital form of cash" (ECB, 2023) available to everyone in the euro area, intended to complement banknotes and coins, with basic use free of charge and the ability to pay both online and offline. On the other hand, CBDCs in general include very different instruments across jurisdictions. Some are aimed at the general public for day-to-day payments (retail, "digital cash"), while others are restricted to financial institutions and used for interbank or securities settlement (wholesale, sometimes described as "tokenised reserves"). CBDCs can be organised as account-based or token-based, run on conventional centralised databases or on distributed ledger technology, and distributed through models that range from direct central-bank provision to two-tier or hybrid architectures involving private intermediaries (BIS, 2023).

Compared with the four properties highlighted above, the distinction is essentially that the digital euro is one arrangement of those properties, whereas "CBDC" refers to the broader set of possible arrangements. Another arrangement is Chinese digital renminbi, where one of the crucial differences lies in anonymity: the

PBoC uses the concept of "managed anonymity" and officially describes a system that minimises data collection to what is necessary for processing (Mu, 2022), while ECB declares privacy at the same level of cash.

3.2. Private digital money

For the purpose of this paper "private digital money" can be defined as monetary instruments denominated in the sovereign unit of account whose ownership and transfer are represented digitally, but where the underlying liability and governance are provided by private entities rather than the central bank. It includes:

1) privately issued claims that function as money for the public (primarily commercial-bank deposits and regulated e-money),
2) the privately governed infrastructures that make those claims transferable at scale (card networks, payment processors, mobile wallets, and similar platforms), and
3) tokenised private claims such as stablecoins, which represent a newer branch of private digital money aiming to maintain parity with sovereign currency while circulating on token networks.

Concrete examples therefore range from current-account balances at commercial banks, to card-network payments (e.g. Visa/Mastercard), to wallet balances in large payment platforms, and to fiat-referenced stablecoins (e.g. USDC/USDT).

The first defining property is the issuer of the liability. The quantitatively dominant form of private digital money is commercial-bank money: a-vista deposits and transaction accounts that households and firms use for payments and day-to-day liquidity management. These balances are liabilities of individual banks, not of the state, even if they are typically redeemable at par into cash and are widely treated as "money" in everyday life. This par convertibility is an institutional achievement rather than a technological fact; it relies on prudential regulation, deposit insurance, and the central bank's capacity to supply liquidity against eligible collateral. A second branch is non-bank issued e-money (prepaid balances and wallet balances), where the issuer is a licensed private institution and the claim is usually backed by safeguarded assets. A third branch are stablecoins: privately issued tokens that promise redemption at a fixed rate into sovereign currency, with the credibility of the promise depending on the quality, liquidity, and legal segregation of reserve assets.

The second property is governance of the ledger and access rules. Unlike cash, private digital money is intrinsically permissioned: holding and transacting typically requires an account or wallet opened under the provider's contractual terms and compliant with identification, monitoring, and permissible-use rules. Governance is distributed across multiple private actors: banks operating core ledgers, payment processors routing messages, acquirers and issuers managing fraud controls and limits, and card networks setting technical standards and pricing schedules. This "platform layer" matters because it determines not only the technical ability to pay but also the economic conditions (fees, rebates, rewards) and behavioural nudges (default payment options, frictionless one-click payments) that shape payment choice (Ching & Hayashi, 2010; Rochet & Tirole, 2003). Stablecoins appear more bearer-like because tokens can be transferred peer-to-peer on a blockchain, but in practice access is still shaped by gatekeepers at on- and off-ramps, by wallet providers, and (in many designs) by the issuer's capacity to freeze or blacklist tokens to comply with regulation.

Settlement finality is the third property. In private digital money the front-end perception of "instant payment" often hides multi-stage back-end processes. A card transaction, for example, is authorised in real time but is cleared and settled later, frequently on a net basis, and can be reversed through chargebacks and dispute procedures. Finality is therefore conditional on platform rules and on the solvency of intermediaries. Account-to-account transfers can achieve near-real-time finality only to that extent as the underlying payment system (often operated or overseen by the central bank) provides rapid interbank settlement in reserves. Stablecoin transfers can have rapid on-chain settlement finality at the token level, but "monetary finality" still relies on the ability to redeem the token for sovereign currency at par and on the legal enforceability of that redemption claim.

Lastly, the fourth property is risk allocation. Because the liability is private, users of private digital money bear (directly or indirectly) issuer credit risk and liquidity risk. For bank deposits these risks are mitigated by capital and liquidity regulation, supervision, and deposit insurance, but they are not eliminated; systemic shocks can still trigger liquidity stress, freezes, or resolution actions. For non-bank e-money and stablecoins, the central risk is that the parity promise is only as credible as the reserve management, custody arrangements, and the legal perimeter governing redemption. Operational and cyber risk is also crucial: because private digital money is ledger-based and networked, outages, cyber incidents, or platform failures can suddenly suspend payments even when the underlying monetary claim remains valid. Finally, legal and regulatory risk is

intertwined with governance. Private digital money is shaped by rules on access, surveillance, sanctions, consumer protection, and competition, which can differ across jurisdictions and providers.

In specific circumstances private digital money can outperform cash on convenience, speed over distance, and integration with e-commerce and data-driven business models. However, it systematically trades autonomy for functionality. Because access is mediated by private actors, private digital money can be priced, surveilled, rationed, or denied, which shifts the balance of power in the monetary system away from bearer possession toward the operators of ledgers and platforms. Importantly, private digital money remains structurally dependent on public money, as it relies on central bank reserves for final settlement between private intermediaries, on the public sector's legal framework to enforce contracts and supervision, and on cash as the ultimate redemption option that anchors par convertibility and preserves an exit from purely digital infrastructures (Brunnermeier & Niepelt, 2019).

4. Discussion

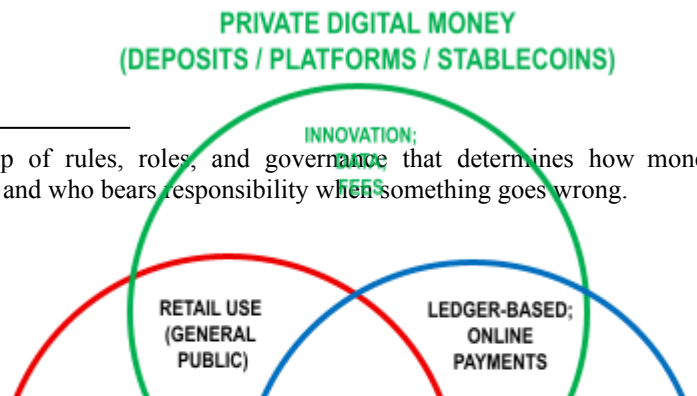
Digitalisation has not produced a single replacement for cash. It has instead generated a layered "multi-money" ecosystem in which public physical money (coins and banknotes), public digital money (central-bank reserves and potentially retail CBDC), and private digital money (bank deposits, payment platforms, and stablecoins) coexist and compete. Because ownership and transfer are validated in records rather than by physical possession, digitalisation relocates money's core functions into an infrastructure layer where governance (public or private) determines access, pricing, privacy, and resilience.

From a balance-sheet perspective, public money and private money form a hierarchy. Physical cash and central-bank reserves sit at the top as the ultimate settlement asset in the domestic unit of account. Private digital money is positioned below in the form of claims on intermediaries, which are expected to remain convertible into public money (at par value). Private platforms such as card networks, processors, and wallet systems add another layer by governing access, pricing, dispute resolution, and data flows, even when the underlying liability remains a bank deposit. This is why debates about "cash versus digital" are incomplete: the relevant comparison is between institutional arrangements[1], not between technical formats.

In such a hierarchy cash plays two distinct roles. It is a public option for everyday payments that provides settlement by transfer of possession rather than by updating private ledgers. No bank, app, card network, or database has to approve it or update a record. The settlement happens momentarily. Secondly, cash provides the option to convert private balances into state-issued money at will. That possibility disciplines private providers and helps keep private money reliably exchangeable at face value, because people always have an alternative if a bank or payment platform becomes risky, expensive, or unavailable. This matters for monetary sovereignty and systemic resilience, because when operational, cyber, or geopolitical risks rise authorities explicitly emphasise the need for cash preparedness (Norges Bank, 2023; ECB, 2025; De Nederlandsche Bank, 2025).

Digital money can reproduce some roles of cash only by weakening others. Because it is ledger-based, it is inherently dependent on infrastructure and on entities that operate, secure, and govern that infrastructure. Even where a CBDC is designed for offline payments, it still relies on devices, secure hardware, and later synchronisation, which means that digitalisation cannot be treated as a pure resilience upgrade. These dependencies also reshape settlement and privacy. Public digital money can be engineered to settle in central-bank money at the moment of transfer, but operational finality remains contingent on system integrity. Private digital payments often appear instant to users while retaining legal and operational reversibility through chargebacks, fraud controls, and delayed settlement. Since digital transfers generate records by default, privacy becomes an explicit design and governance choice rather than an intrinsic property, and access is typically permissioned through identification requirements and contractual terms. Therefore, cash continues to complement digital instruments not only as a backup in disruptions, but also as a public option that supports autonomy and behavioural budgeting and spending control. Figure 1 and Table 1 summarise these trade-offs.

Figure 1. Overlapping roles of cash, public digital money, and private digital money



[1] Overall setup of rules, roles, and governance that determines how money is issued, accessed, transferred, and settled, and who bears responsibility when something goes wrong.

Source: author

Figure 1 provides a stylised Venn diagram of the functional overlaps and the distinctive roles of public physical money, public digital money, and private digital money. The Venn representation highlights that all three forms can serve as a means of payment and store of value in the same unit of account, but they differ in how they deliver these services. The distinctive cash region is defined by offline bearer transfer, immediate settlement, and strong privacy. The public digital region is defined by central-bank liability combined with digital operability, which necessarily implies explicit governance choices about access and data. The private digital region is defined by innovation and integration, but also by gatekeeping, pricing power, and pervasive data generation (Rochet & Tirole, 2003).

Table 1. Characteristics and monetary functions of physical cash and major forms of digital money

Characteristics / Functions	**Cash (coins & banknotes)**	**Central bank reserves (wholesale)**	**Retail CBDC**	**Commercial bank deposits**	**E-money (wallet/ prepaid)**	**Stablecoins (fiat-referenced)**
Public money (central-bank liability)	✓	✓	✓	x	x	x
Directly usable by the general public	✓	x	✓	✓	✓	✓
Transfer by possession (bearer instrument)	✓	x	x	x	x	x
Operates without internet, electricity, or battery-powered devices	✓	x	x	x	x	x
Ledger-based (records required to transfer)	x	✓	✓	✓	✓	✓
Immediate settlement finality at point of payment	✓	✓	✓	x	x	✓
High transactional privacy / anonymity as a default (intrinsic) property	✓	x	x	x	x	x
User exposed to issuer credit risk	x	x	x	✓	✓	✓
Reversible by operator / provider	x	x	✓	✓	✓	✓
Note: Retail CBDC features such as offline functionality, privacy safeguards, and reversibility are design-dependent and vary across jurisdictions. Even in offline mode CBDC remains device-based and cannot replicate cash's infrastructure-free operability. Stablecoin "finality" refers to on-chain transfer settlement and does not eliminate redemption, governance, or legal risk.						

Source: author

The above presented ecosystem perspective clarifies why digital money reshapes rather than eliminates cash. Private digital money and platforms dominate routine, high-frequency transactions because they bundle payments with convenience and complementary services, but this comes at the cost of increased dependency, reduced privacy, and greater concentration of power in private infrastructures. Public digital money can mitigate some of these issues by providing a digital public basis, but it introduces governance and operational risks that must be addressed through design and legal safeguards. In this setting, protecting cash is not a resistance to innovation, it is an explicit resilience and inclusion strategy that preserves a bearer-based public option within an increasingly platform-mediated monetary system.

5. Conclusion

This paper examined how the expansion of digital money reshapes the position of physical cash in the monetary system, and why the widespread "end of cash" narrative remains incomplete when money is treated as an institutional arrangement rather than just a technological format.

In order to achieve this, the contemporary monetary landscape was organised into three coexisting forms: public physical money (coins and banknotes), public digital money (central-bank liabilities in digital form, including prospective retail CBDC initiatives), and private digital money (commercial-bank deposits, platform-mediated payment infrastructures, and stablecoins). These forms were then compared through a set of core properties (issuer and liability structure, governance and access rules, settlement finality, and the allocation of risks) which were linked to the practical roles and functions that society expect money to fulfil.

The central finding is that digitalisation has not produced a single functional substitute for cash. Instead, it has created a layered ecosystem in which many everyday payments shift toward ledger-based instruments that are more convenient and more easily integrated into online commerce, but that also increase dependency on intermediaries, infrastructure, and explicit governance choices. In that environment cash remains unique because it combines bearer transfer with offline operability, immediate settlement by transfer of possession, and inherently high privacy. These features are not optional "add-ons" but consequences of cash's physical form. As a result, digital instruments can mimic some of cash's advantages only by accepting trade-offs elsewhere, which means that the key policy question is not whether cash can be replaced, but which combinations of monetary roles a society is willing to preserve or relinquish.

Additionally, monetary hierarchy was recognized. Public money provides the anchor of the unit of account, while most private digital money consists of layered claims on intermediaries that are expected to remain exchangeable at face value into public money. Within this hierarchy cash performs critical roles. It is a public option for everyday payments that does not require the approval of ledger operators, and it is an option that strengthens convertibility by giving the public a direct exit from private money and private platforms. This option matters not only in crises but also in regular times, because it disciplines private providers and helps sustain trust in the broader payment system when digital services become expensive, unavailable, or operationally fragile.

These conclusions carry broader implications. For governments and central banks, treating cash as a residual legacy instrument risks weakening resilience, inclusion, and monetary sovereignty precisely when operational, cyber, and geopolitical risks make redundancy valuable. Protecting cash is therefore not a rejection of innovation, but a deliberate strategy to preserve a bearer-based public option alongside increasingly platform-mediated payments. For the design of public digital money, the analysis implies that objectives such as final settlement, privacy, and universal access cannot be pursued independently, as they require explicit choices about architecture, offline functionality, limits, and data governance, and they inevitably introduce new operational and governance risks even when they reduce private-issuer credit risk. For private subjects (banks, payment platforms, and stablecoin issuers) the framework clarifies that their products' competitiveness is tied not only to user experience but also to trust, governance, and the credibility of par convertibility, and that regulatory attention will continue to focus on the distribution of risk and control embedded in platform rules and reserve arrangements.

The paper has its limitations. It is primarily conceptual and synthetic, and focuses on ideas and frameworks rather than on new data or measurements, as its approach is not quantitative. The categorisation into public digital and private digital money is analytically useful but simplifies a reality in which hybrid designs, jurisdiction-specific legal frameworks, and rapidly evolving technologies can blur borders. The discussion of privacy, offline use, and settlement finality depends on design assumptions that may differ across implementations. However, these limitations are a consequence of the paper's purpose and are expected to be addressed in the future studies.

Future research can also strengthen the arguments in multiple directions. First, empirical work should quantify how cash availability affects resilience during outages, cyber incidents, and disruptions, and how preparedness policies change payment behaviour and trust. Second, micro-level studies should examine the behavioural and distributional aspects of cash use—particularly for vulnerable groups and in settings where access is constrained by fees, identification requirements, or digital literacy—so that inclusion claims about digital instruments can be evaluated against observed outcomes. Third, as public digital money projects advance, research should focus on concrete design trade-offs in offline functionality, privacy safeguards, and governance, and on how those choices interact with competition in private payment platforms and the stability of bank-based money. Together, these lines of inquiry would move the discussion from broad comparisons toward evidence-based design and policy choices in a multi-money system where cash remains institutionally distinct.

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