JOURNAL
OF EUROPEAN ECONOMY
Vol. 23. № 1 (88). January–March 2024
Publication of West Ukrainian National University

Economic Theory

Viktor KOZIUK

MONETARY SOVEREIGNTY: DIGITALIZATION AND THE CBDC TRILEMMA

Abstract

Digital transformation has put significant pressure on monetary sovereignty. This pressure is channeled through the introduction of private digital payment services, cross-border operations, currency substitution, and the internationalization of foreign currencies. While most contemporary research views the introduction of a central bank digital currency (CBDC) as a key option for safeguarding monetary sovereignty in the digital age, we argue that the link between monetary sovereignty and CBDC adoption may be somewhat overstated. First, our empirical test shows that current progress in CBDC adoption is more closely correlated with indicators of financial development and innovation than with indicators of crypto ecosystem development. Second, considering the CBDC as a means to enhance the currency's international status necessitates greater involvement in the competition to attract numerous non-resident users, which can potentially disconnect the design of the CBDC from the internal goals of its adoption. Third, this competition gives rise to a trilemma of incompatibility between monetary sovereignty, global acceptance of the CBDC design, and internationalization of the central bank's digital currency. Nevertheless, this does not imply that central banks should refrain from investing efforts in preparing for further digital transformations. Rather, it means that monetary sovereignty should not be seen as absolute.

Koziuk, Viktor, DSc (Econ), professor, head of the Department of Economics and Economic Theory, West Ukrainian National University, Ternopil, Ukraine. ORCID: 0000-0002-5715-2983 Email: victorkozyuk@ukr.net

Key Words:

CBDC, central banks, cryptocurrencies, currency internationalization, monetary sovereignty.

JEL: E58, E59, O23, Q33.

1 figure, 3 tables, 85 references.

Problem Statement

Under the influence of digital transformation, interest in monetary sovereignty has surged. Until recently, dollarization was seen as perhaps the greatest challenge to monetary sovereignty, albeit in low- and middle-income economies. In wealthier economies, developed financial systems and price stability have shielded them from such concerns. Except for the countries that formed the European Monetary Union, developed economies have generally taken monetary sovereignty for granted.

Global financial integration has brought its own changes, often giving the issue of monetary sovereignty an air of monetary autonomy. It is important to specify that monetary sovereignty refers to the exclusive ability of a country's public authorities to exercise official control over its own currency. This control includes ensuring that money fulfills its function as legal tender, controlling the issuance of money, and managing the withdrawal of official means of payment from circulation. In contrast, monetary autonomy pertains to the ability of a country's central bank to ensure money supply or control interest rates within the economy in accordance with domestic macroeconomic conditions, independent of external influences. For example, Aizenman (2019a) noted that the trilemma of monetary choice in an open economy carries significant implications for the structure of the financial system and the nature of central bank regulation, thus touching on the issue of monetary sovereignty. That is, in an open economy, the issues of monetary autonomy and monetary sovereignty converge.

While discussions on monetary autonomy and the respective trilemma are commonplace (Rey, 2013, 2016; Aizenman, 2019b; Aizenman et al., 2016; Miranda-Agrippino & Rey, 2020; Miranda-Agrippino & Ricco, 2021), the debate on monetary sovereignty has intensified under the influence of the digitalization of money. The emergence of cryptocurrencies has sparked a wave of crypto-enthusiasm, prophesying the factual weakening of central banks' influence in the digital future. These discussions have their roots in several early studies (Bordo & Levin, 2017; Raskin & Yermack, 2016; Mancini-Griffoli et al., 2018; Tucker, 2017). However, the volatility of the cryptocurrency market and scalability issues have tempered the euphoria surrounding the extension of distributed ledger technology (DLT) into the monetary sphere (Panetta, 2023). Instead, the rise of stablecoins suggests that the integration of assets and payment instruments, coupled with new opportunities in payment services, may pose serious challenges to traditional fiat money. One possible response by central banks to this technological challenge is the introduction of central bank digital currency (CBDC) (Brunnermeier et al., 2019). At first glance, CBDC appears to be a response to the threat to monetary sovereignty posed by digitalization.

However, the ongoing debate over the design of central bank digital currencies suggests that CBDCs may not only provide a solution to the problem, but may constitute the problem itself (UK Parliament, 2023). In the digital world, the nature of money will make it increasingly complex for currencies to compete in fulfilling separate functions of money (Brunnermeier et al., 2019). Under the influence of digitalization, the internationalization of currencies will put additional competitive pressure on the circulation of fiat money. Moreover, if success in achieving international currency status is linked to the adoption of CBDC, competition in CBDC designs will inevitably raise concerns about monetary sovereignty.

In this article, the impact of digitalization on monetary sovereignty is considered from the following perspectives. If the proliferation of cryptocurrencies indeed poses a risk to monetary sovereignty, then this should be reflected in how certain structural factors influence the progress made by central banks in adopting CBDCs. If CBDCs are to be seen as a driver of currency internationalization, then the desire to attract a broader base of non-resident users requires that currency competition extends into the realm of CBDC design. Currency internationalization driven by the competitive advantages of national CBDCs inevitably gives rise to the trilemma of monetary sovereignty, global acceptance of central bank digital currencies, and their internationalization. Out empirical test shows that progress in CBDC adoption is not primarily driven by concerns about digital challenges to monetary sovereignty. Instead, it is the trilemma of choosing between the internationalization of CBDCs, their globally acceptable designs, and monetary sovereignty that may have a long-term structural impact on central bank decisions.

Literature Review

Digitalization has brought the complexity of a country's sovereignty to the forefront. Digital sovereignty is a good example of how the competitive advantages of global firms in digital technologies can prevent public agencies from performing their functions efficiently or acquiring them at non-monopoly prices (Kreutzer & Molina Vogelsang, 2023; Floridi, 2020). In essence, governments are finding it increasingly difficult to maintain the quality of public services in a digital landscape dominated by private companies. However, developing an alternative infrastructure to such companies appears to be a costly endeavor. Similarly, regarding monetary sovereignty, private digital money can potentially better serve the needs of economic agents compared to available fiat money alternatives. However, the erosion of monetary sovereignty can lead to a weakening of the stabilizing effect of monetary policy and the frustration of a whole range of regulations related to customer identification.

Conceptually, a technological prerequisite for the threats to monetary sovereignty in the digital realm is the unbundling of the functions of money. The unbundling of money arises from the emergence of new payment services, the blurring of boundaries between money and assets, and the programming of money and its tokenization. Together, these developments give rise to a true alternative to traditional fiat currency, leading to more complex structural outcomes such as the formation of «optimal digital areas» (Brunnermeier et al., 2019; James et al., 2019). The monopoly rents generated by data-driven businesses distort resource allocation, while traditional financial intermediation faces disruption from platforms and a general increase in systemic instability due to heightened information asymmetry (IMF, 2021; Hernandez de Cos, 2023; Panetta, 2022; Frost et al., 2019; Doerr et al., 2023).

Zimmermann (2013) notes that the scientific analysis of monetary sovereignty has shifted toward political and legal studies, focusing on the efficiency of government institutions in realizing state power. However, digitalization has renewed the interest of economists in monetary sovereignty. This is evident in the analytical materials of many international organizations and central banks (Brooks, 2021; Soderberg et al., 2023; Waliczek, 2023; Panetta, 2022; Hernandez de Cos, 2023).

In the digital realm, the debate over the monopoly on issuing legal tender is reminiscent of the early days of fiat money, when the institution of the money monopoly was just emerging. Throughout history, competition among privately issued currencies has shown that ensuring monetary sovereignty touches on the positive externalities of price stability and serves as a key prerequisite for financial stability and the efficiency of tax collection (Gorton and Zhang, 2022). According to Martino (2023), it is due to stability concerns that the competition between pri-

vate and public money is regulated by formal legal measures. As a result, the erosion of monetary sovereignty induced by digital technologies forces central banks to respond. Restoring the legitimacy of existing forms of monetary regulation – ones that do not interfere with the opportunities presented by technological progress – requires proactive responses.

The question of whether the competition between central bank money and private money promotes stability in monetary processes or, on the contrary, poses a threat to financial stability, remains a subject of the ongoing academic debate on the fundamental nature of central banks and money (Tobin, 1969; Holmström & Tirole, 1998; Kocherlakota, 1998; Borio, 2019; Schnabel & Shin, 2018; Brunnermeier & Niepelt, 2019). Brunnermeier and Niepelt (2019) further discuss the allocative consequences of changes in the structure of the money supply, considering the division of money into inside and outside money, and conclude that the introduction of CBDC is unlikely to have substantial negative effects. On the other hand, as shown by Abad et al. (2023), the issues of CBDC design, banking sector concentration, and the nature of competition in credit and deposit markets may be important for reasons of equivalence between private and public money (Agur et al., 2022; Andolfatto, 2021; Fernández-Villaverde et al., 2021). Nevertheless, these issues are not expected to impede central bank's ability to conduct monetary policy, with potential changes likely to focus on fluctuations in excess liquidity and the adjustment of the operational design of monetary policy (Abad et al., 2023).

However, we must acknowledge that the debate surrounding the equivalence of private and public money primarily centers on the allocative consequences stemming from changes in inside and outside money. The introduction of CBDCs is mostly analyzed in terms of the changes in volumes of both types of money within the structure of the money supply and the elasticity of the financial system. The issue of monetary sovereignty, on the other hand, is not so much focused on the equivalence of inside and outside money, but rather on how the role of both inside and outside money may simultaneously weaken due to technological advancements. In other words, the primary question of why CBDCs should be considered a response to technological change takes precedence over their effect on the equivalence of inside and outside money. It is through this perspective that the issue of monetary sovereignty arises in the digital realm. This viewpoint continues the older debate on the competition between different forms of money, rather than solely focusing on the equivalence of inside and outside money (Gorton & Zhang, 2022; Martino, 2023).

We can identify several channels through which new forms of money may undermine monetary sovereignty.

The first channel involves structural changes in payment services, which may lead to a decreased the demand for central bank money within the banking sector to a point where the effectiveness of interest rate policy declines sharply.

The consensus among scholars (Bordo & Levin, 2017; Raskin & Yermack, 2016; Mancini-Griffoli et al., 2018; Tucker, 2017; Brooks, 2021; Soderberg et al., 2023, Waliczek, 2023; Panetta, 2022) is that digitalization can diminish the need for reserves, as uninterrupted payment operations can be maintained without central bank liquidity support. Panetta (2022) and Hernandez de Cos (2023) also emphasize the importance of strategic autonomy, proposing the development of payment instruments less reliant on foreign private agents to counterbalance the market power of non-resident payment systems.

The second channel concerns the control over cross-border operations. Karau (2021), for example, provides empirical evidence suggesting that some cryptocurrencies are assuming the role of key currencies by acting as intermediaries in cross-border operations. This immediately raises the question of the motivations behind the implementation of capital flow regulations: Are cryptocurrency-mediated cross-border operations an extension of the traditional monetary autonomy problem, albeit in a new technological setting? Or are they the result of inefficiencies in traditional approaches to capital controls driven by concerns about macroeconomic stability? Digitalization creates new opportunities for cross-border operations, bringing the issue of monetary sovereignty closer to that of monetary autonomy. The «optimal digital area» approach (Brunnermeier et al., 2019; James et al., 2019) clearly shows that economic agents can converge on preferences for specific forms of money and payment services that offer better user experiences in facilitating the fulfillment of specific functions of money. In other words, digital money is a priori a challenge to an arbitrary «Westphalian» model of monetary sovereignty (Murau & van't Klooster, 2022).

The third channel pertains to currency substitution, where digital money presents a challenge to monetary policy akin to the risks associated with dollarization (Bordo & Levin, 2017; Mancini-Griffoli et al., 2018; Agur et al., 2019). The enhanced ability of the new forms of money to provide arbitrary protection against the risks of currency depreciation and financial sector instability while satisfying payment needs significantly narrows the space for the effectiveness of monetary transmission. This digital dollarization raises the problem of the resilience of financial intermediation (Mancini-Griffoli et al., 2018; Adalid et al., 2022). Zhu and Hendry (2019) demonstrate that the competition between fiat central bank currencies, whose share in circulation is declining, and cryptocurrencies may contribute to an increase in the inflation rate. However, the motivation to own cryptocurrencies is not solely driven by the level of inflation (Koziuk, 2022). Rather, trust in cryptocurrencies is stronger in countries with a history of traumatic inflation and weak de facto central bank independence (Koziuk, 2021a). Thus, underestimating the role of institutional preconditions as a factor of monetary stability may undermine monetary sovereignty in the future.

The fourth channel concerns foreign currency internationalization. While similar to the cross-border operations control channel, it has important distinguishing characteristics. Here, foreign-issued CBDCs with comparative advan-

tages, such as superior user experience, access to globally significant platforms, and the ability to operate within the currency zone of a large economy, can influence the monetary sovereignty of other countries. Naef et al. (2022), Eichengreen et al. (2022), Iancu et al. (2020), and Prasad (2023) observe that an alternative trajectory for currency internationalization is possible, and it is associated with CBDC. Buckley and Trzecinski (2023) and Huang and Mayer (2022) highlight digital technologies as an important factor in intensifying competition among international currencies. Cong and Mayer (2022) contend that countries eager for dominance in currency competition are primarily motivated to pursue the adoption of CBDCs. Frankel (2023) underscores the crucial role of techno-nationalism in motivating the adoption of CBDC.

Taking into account the unique aspects of the impact of the digital transformation of money on various aspects of currency competition, most researchers tend to view CBDCs univocally as a way to respond to both the challenges posed by digitalization-based currency internationalization and the challenges posed by currency substitution and reduced demand for central bank reserve money. Rarely, if ever (UK Parliament, 2023), are CBDCs seen as a response to challenges to monetary sovereignty from the side of digitalization (Brunnermeier et al., 2019; Brooks, 2021; Soderberg et al., 2023; Waliczek, 2023; Panetta, 2022; Hernandez de Cos, 2023).

This article offers a threefold perspective on CBDC as a response to threats to monetary sovereignty. Through empirical analysis of the relationship between cryptocurrency expansion by country and a number of structural factors, we argue that while the threat from private digital money may be somewhat exaggerated today, it should not be entirely dismissed. The introduction of CBDCs can activate competition between them, with design likely serving as a means of such competition. Making CBDC accessible for ownership by non-residents can be seen as a way to offer the CBDC design that promotes the internationalization of the respective currency. As a result, competition among international currencies could shift to the realm of CBDC design to attract a broader user base across borders. This, in turn, raises the question of whether pursuing a globally acceptable CBDC design aligns with the logic of national monetary sovereignty. Such situation can be described as a trilemma of objectives, referring to the impossibility of simultaneously achieving monetary sovereignty, rapid currency internationalization, and a globally acceptable CBDC design.

Research Results

Factors driving the progress of CBDC projects: Analysis from the perspective of risks to monetary sovereignty

The proliferation of cryptocurrencies and the development of new payment technologies are seen as key concerns for monetary sovereignty in the digital era (Bordo & Levin, 2017; Raskin & Yermack, 2016; Tucker, 2017; Brooks, 2021; Soderberg et al., 2023; Waliczek, 2023; Panetta, 2022; Hernandez de Cos, 2023). One might logically assume that variables indicating the expansion of cryptocurrencies or the maturity of crypto ecosystem should correlate with central bank activity concerning CBDCs. However, there are caveats. For example, CBDC-related activity may signal underlying concerns about safeguarding monetary sovereignty, even though official communications on CBDC projects may emphasize considerations such as financial inclusion. Huang and Mayer (2022) demonstrate that, for instance, China and the United States are pursuing different paths regarding cryptocurrency regulation, a contrast reflected in the positioning of their CBDC projects. China has opted to ban cryptocurrencies while actively advancing the development of the digital yuan. In contrast, the United States is allowing space for financial innovations based on crypto technologies but is not expediting the digital dollar project.

Prior empirical studies on CBDC adoption have largely overlooked the issue of monetary sovereignty. For example, Auer et al. (2020, 2023) conducted a quantitative assessment of central banks' progress toward implementing CBDC projects. They examined the relationship between their respective index and structural indicators such as financial inclusion, transfer volumes, and the role of cash. The results indicated that central banks are developing CBDCs to enhance payment services and their accessibility. Utilizing the index of progress in CBDC (Auer et al., 2020), Koziuk (2021a) demonstrated the significance of financial development and innovation as criteria for CBDC implementation. Furthermore, Koziuk (2021b) argued that, theoretically, the average level of central bank independence provides a better explanation for advancements towards CBDC adoption.

To empirically assess whether concerns about monetary sovereignty do indeed influence central banks' motivations to promote CBDC projects, we utilized the following data:

- As dependent variables, we employed the quantitative indicator proposed by Auer et al. (2020) and the quantitative indicator for measuring

the progress of CBDC projects based on the Atlantic Council CBDC Tracker data for September 2023. The latter involved assigning values to different stages: Launched – 5; Pilot – 4; Development – 3; Research – 2; Inactive – 1; Canceled – 0. Two variables were chosen to assess the reliability of associations and to accommodate differences in the approaches to assigning quantitative values and timing of assessments.

- As independent variables characterizing the expansion of the crypto ecosystem, we utilized the Crypto Adoption Index and the share of the population that owns bitcoins (for a more detailed analysis of bitcoin ownership, see Koziuk (2022)). Given that the expansion of the crypto ecosystem may be perceived as a challenge to monetary sovereignty, the promotion of CBDC projects must be a response to this challenge, thus, the expected relationship should be positive.
- As other independent variables, we selected the Democracy Index, the Global Innovation Index, the Financial Development Index, and the interaction of the Global Innovation Index and the Financial Development Index providing a combined characteristic of the technological capability and the level of financial sector development. These independent variables characterize both supply-side capabilities and demand-side requirements. The detailed methodology is presented in Koziuk (2021a). In terms of the variables selected, this approach differs from that of Auer et al. (2020, 2023), who place greater emphasis on indicators that may potentially indicate demand.

The results of the univariate regression model analysis are presented in Tables 1 and 2. In general, the obtained results across two different dependent variables were very similar, although the statistical properties of the models were slightly better when using the quantitative indicator from Auer et al. (2020). To a first approximation, this similarity may be explained by the increasing interest in CBDC over time, which leads to a reduction in the influence of structural factors in favor of random factors associated with the bandwagon effect.

The results presented in Tables 1 and 2 show that all selected variables have a correct direction of association consistent with theoretical predictions and show statistical significance (except for the Democracy Index in Table 2, where the statistical significance is somewhat insufficient compared to Table 1). However, while the variables characterizing the expansion of the crypto ecosystem (specifications 1-2 in both tables) show statistical significance, the strength of their association with the dependent variables is significantly weaker compared to that of the variables measuring financial development and the propensity to innovate (specifications 4-6 in both tables).

Table 1

Results of the empirical analysis with the quantitative indicator of CBDC progress from Auer et al. (2020) as the dependent variable

	(1)	(2)	(3)	(4)	(5)	(6)
CAdInd	1.393778 (2.307283) 0.022584					
%Pop		0.120289 (3.548146) 0.000549				
Dem Ind			0.119426 (4.31569) 0.000030			
FinDev				1.998610 (8.36642) 0.000000		
GlobInn					0.035401 (6.36397) 0.000000	
FinDev* GlobInn						0.033528 (7.454004) 0.000000
R2	0.038	0.092	0.109	0.317	0.254	0.320
	F(1.133) = 5.3236	F(1.124) = 12.5893399	F(1.143) = 18.6251597	F(1.151) = 69.9970015	F(1.119) = 40.5001644	F(1.118) = 55.562172

Notes: CAdInd – Crypto Adoption Index; %Pop – percentage of population that owns bitcoins; Dem Ind – Democracy Index; FinDev – Index of Financial Development; GlobInn – Global Innovation Index; FinDev*GlobInn – interaction of Global Innovation Index and Financial Development Index. Source: author's calculations using the package STATISTICA.

Regarding the differences across the dependent variables, the following can be noted. The weaker association between the Democracy Index and the dependent variable in Table 2 compared to Table 1 can be attributed to the increasing number of countries with less democratic regimes moving towards CBDCs. In addition, the strongest association with the first dependent variable was shown by the interaction of the variables characterizing financial and innovation development (specification 6 in Table 1). In contrast, when the indicator based on the Atlantic Council CBDC Tracker was used as the dependent variable, the strongest association was found for the Financial Development Index variable (specification 4 in Table 2).

Table 2

Results of the empirical analysis with the quantitative measure of CBDC progress from the Atlantic Council CBDC Tracker as the dependent variable

	(1)	(2)	(3)	(4)	(5)	(6)
CAdInd	1.758340 (2.40865) 0.017806					
%Pop		0.105550 (2.51618) 0.013471				
Dem Ind			0.066778 (1.703263) 0.091395			
FinDev				1.618411 (4.38610) 0.000026		
GlobInn					0.028151 (3.828489) 0.000229	
FinDev* GlobInn						0.022390 (3.60479) 0.000500
R2	0.053	0.060	0.026	0.146	0.131	0.12
	F(1.102) = 5.80160663	F(1.99) = 6.3312	F(1.108) = 2.90110556	F(1.133) = 19.2378314	F(1.97) = 14.6573263	F(1.95) = 12.9944805

Notes: CAdInd – Crypto Adoption Index; %Pop – percentage of population that owns bitcoins; Dem Ind – Democracy Index; FinDev – Index of Financial Development; GlobInn – Global Innovation Index; FinDev*GlobInn – interaction of Global Innovation Index and Financial Development Index. Source: author's calculations using the package STATISTICA.

This suggests that, over time, technological capability is less of a constraint on interest in CBDCs. Instead, factors related to how a central bank assesses the need for its own digital currency from the perspective of the development of the financial system are coming to the fore.

Based on this empirical test, it can be concluded that the motivation for promoting CBDC projects is much less related to concerns about monetary sovereignty, provided they are defined as the expansion of the crypto ecosystem. While one cannot completely dismiss the idea of a direct link between these phe-

nomena, following the logic of «the expansion of the crypto ecosystem – risks to monetary sovereignty – responses of central banks – promotion of CBDC projects», financial development and innovation seem to be stronger incentives for the development of central bank digital currencies. However, there might be an indirect link between how financial development, at a certain stage, integrates innovation, thereby creating structural preconditions for the deterioration of monetary sovereignty in the future. At present, this hypothesis warrants further investigation. The development of the crypto ecosystem seems to be driven more by the institutional vulnerability of monetary authorities (Koziuk, 2022). Therefore, it poses a threat to monetary sovereignty not so much in a technological sense but rather in terms of currency substitution. Given the varying levels of trust in digital currencies across countries that have been more and less successful in managing inflation (Koziuk, 2021a), the cryptocurrency-related determinants of risks to monetary sovereignty may currently be somewhat exaggerated. However, technological progress may lead to more radical innovations in the field of payment services, that require central banks always to be ready to invest efforts in supporting monetary sovereignty. The digital world is evolving rapidly. Therefore, the effectiveness of monetary policy and financial regulation should be based on the sufficient technological capacity of the central bank.

Competition of CBDC designs

The issue of currency competition has traditionally been viewed through the lens of the private versus public money debate (Tobin, 1969; Holmström & Tirole, 1998; Brunnermeier & Niepelt, 2019) or in light of the functioning of the global monetary system. In the latter case, we are discussing competition for the status of international currency or among currencies that have already achieved such status. Eichengreen (2021), Eichengreen et al. (2022), Eichengreen and Viswanath-Natraj (2022), Iancu et al. (2020), Prasad (2023), Buckley and Trzecinski (2023), Huang and Mayer (2022), Frankel (2023), Chahrour and Valchev (2023), and Chorzempa (2021) considered the impact of digitalization on global monetary competition. Their position can be summarized as follows: technological change creates alternative possibilities for currency internationalization. Digitalization can create a competitive advantage for a currency that plays the role of an international medium of exchange, compensating for the presence of restrictions on capital transactions. However, Cohen (1998, 2006, 2012, 2015), Cohen and Benney (2014), Krugman (1984), Flandreau and Jobst (2009), Kenen (2011), Eichengreen (2011a, 2011b, 2019), Gopinath and Stein (2021), and Farhi and Maggiori (2018) emphasize that the status of an international currency is determined by a number of fundamental factors. However, this does not preclude a discussion of an algorithm for a currency to achieve international status and the

relative weight of the scale of the issuing country, monetary stability in that country, or the quality of institutions, etc.

Cong and Mayer (2022) present another perspective on currency competition. They frame the introduction of CBDC as conferring first-mover advantages in the competition between fiat and digital currencies, as well as among international currencies. They emphasize that achieving a certain international currency status is seen as an important criterion for decisions on leadership in the promotion of CBDCs. Essentially, the model proposed by Cong and Mayer (2022) suggests that the international leadership criterion constitutes a significant motivator for accelerating the adoption of a central bank digital currency.

While Cong and Mayer's (2022) model elucidates the steps countries might take to implement CBDCs, it is worth taking a step forward and projecting how competition among central bank digital currencies might unfold. It should be noted that the motivation for such competition revolves around the likely shifts in internationalization processes driven by digitalization (Prasad, 2023). Since digitalization is unlikely to shatter the reserve currency system, but may affect international currencies in cross-border transactions, the competitive gains will be greater the larger the user base of the CBDC, encompassing both residents and non-residents. Broader coverage will facilitate the consolidation of the «optimal digital area» based on network effects. Consequently, CBDC issuers should compete primarily for the strength of these network effects if digitalization is to be considered a prerequisite for strengthening or maintaining the status of an international currency.

In order to achieve more sustainable positive network effects by reaching more residents and non-residents, a CBDC must deliver more than just technological benefits. A design must be proposed in which the appropriate functionality would satisfy the broadest needs in the sphere of payments and the interface would be user-friendly. For simplicity, let us confine our discussion to design in its broadest sense. In this context, global CBDC competition is inevitably based on consumer preferences for different designs. And here it can be seen that since the CBDC design is not the product of competition between private agents, competition can occur on several levels. First, there is competition at the level of trust in the issuing institution. Second, there is competition at the level of the design elements of a CBDC as a product with respective functionality, regulation, and customer experience.

With respect to the former, the institutional dimension of the design problem comes to the fore, as privacy safeguards, AML/KYC procedures, transaction tracking, and the like are not simply matters of central bank professional judgment, but rather political-economic or political-legal constructs. Covert social surveillance technologies, global intelligence gathering, or concerns about money becoming a means of redistributing power between individuals and governments can create biases about the feasibility of owning CBDCs from certain issuers. Cul-

tural aspect is equally important. Different societies have different attitudes towards privacy. And the trade-off between privacy and functionality may turn out to be institutionally rather than culturally determined (Koziuk & Ivashuk, 2022).

Institutional confidence includes, in addition to the issue of consistency between preferences for CBDCs and their designs, the extent to which the proposed design will not be subject to secondary or hidden modifications for purposes other than those outlined in the policy for issuing and maintaining the operation of a CBDC. This raises the question that the policy regarding the design of central bank digital currency potentially falls under the problem of dynamic inconsistency. In its most general form, it can be formulated as follows. Initially, the issuing central bank seeks to attract a significant user base by offering a CBDC design geared towards maximizing social welfare, along with creating preconditions for strengthening its status as an international currency. However, there is risk that the central bank may later change or modify its CBDC design in such a way as to achieve goals that go beyond best user experience and efficiency of payment services (see Table 3 for more details). Changes in the design of digital currency may occur once the number of users reaches a certain level, sufficient to trigger strong network effects as exit barriers.

If issuers are aware of the likely distrust in the correspondence between ex-ante and ex-post promises, then they can react by trying to offer such design elements that would compensate for the «discomfort» of consumers. One might assume that such compensation would rather increase competition regarding CBDC design elements.

The competition algorithm at the design level can generally be conceptualized as a «race to top» model. In this scenario, each successive stage of competition aims to introduce design enhancements that confer functional and user advantages. For example, CBDCs may initially compete based on factors such as better user interfaces, the convenience of AML/KYC procedures, supported transaction size, or maximum transaction amount. Competition then intensifies regarding other compatible CBDCs, the right to conduct international transactions, the right to conduct asset transactions, the right to acquire non-resident assets, etc. Subsequent stages may involve the integration of smart contract elements or other forms of transaction programming. Finally, competitive offerings are likely to include rewards on balances in electronic wallets or even direct access to the central bank's interest rate corridor, representing the «top» level of competitive features.

This begs the question: why doesn't the CBDC enter the «market» with a design that maximizes consumer appeal? Would monetary sovereignty be better served by taking the lead in adopting the CBDC, as suggested by the Cong and Mayer (2022) model? The answers to these questions suggest that the hypothetical competition to attract more users may not necessarily materialize because the CBDC design policy, demand for CBDC, and design preferences are subject to a number of constraints that are likely to challenge the priority of monetary sover-

eignty in the digital world. Thus, the compatibility between monetary sovereignty and currency internationalization is not a presumption guaranteed by the central bank digital currency. This situation can be described as a trilemma.

Table 3

CBDC design in light of the dynamic inconsistency problem

Elements of the dynamic inconsistency problem	Interpretation of the elements of the dynamic inconsistency problem regarding the CBDC design
Optimal policy in the long term	Promoting the design that would satisfy the needs of customers regarding functionality, user interface, cost of usage, and technological efficiency
Deviations from optimal policy in the long term	Design changes that extend beyond the frames of utility maximization for owners of CBDC.
Nature of the conflict of goals	Changes in the CBDC design that redistribute political and economic power in favor of the government.
Reaction of economic agents	Users may become less interested in owning those CBDCs in which they have no trust due to the lack of institutional guarantees to protect their rights. However, they may find it challenging to stop using such money because of the network effects, which could lead to a situation where there is a temptation to use exit barriers to manipulate the design ex-post.
Shift in policy focus	Expanding the perimeter of competition to elements of CBDC design; monopolistic competition for access to advantages of participating in one network or another.
Nature of disequilibrium	Additional restrictions on exit and excessive incentives for access
Remedial measures	Competition among leading issuers; international design standards; clear design compliance protocols for ensuring interoperability.

Source: created by the author.

The CBDC trilemma: between monetary sovereignty, currency internationalization, and optimal design

CBDC has been analyzed for conflicting objectives in a number of papers. For example, Schilling et al. (2020) pointed to a conflict between the central bank's ability to maintain price stability, prevent banks run, and maintain an optimal amount of CBDC in circulation. The analysis by Schilling et al. (2020) assumes that the demand for CBDC is unconditional, leaving the question of design aside. Bjerg (2017) also argued that the introduction of CBDC would have implications for changes in the nature of the money supply and emphasized the importance of choosing an appropriate design. According to Bjerg (2017), the profile of conflict scenarios follows directly from the design. These scenarios include: the «money manager» scenario, where CBDC coexists with commercial bank deposits and there is no cash; the «money maker» scenario, where CBDC coexists with cash and there are no commercial bank deposits; and the «money user» scenario, where CBDC coexists with both cash and commercial bank deposits. Bjerg (2017) highlights the impossibility of achieving monetary sovereignty, free convertibility of cash into CBDC, and parity between central bank digital money and bank money simultaneously, thus presenting the trilemma of choice. Furthermore, it should be noted that Bjerg's analysis does not thoroughly consider the demand side and how such demand can be influenced by design choices. The stark opposition of CBDC to other forms of money may be overstated. Eichengreen (2022) also pointed to the trilemma problem, suggesting that central banks are unlikely to be able to ensure the confidentiality of transactions due to the nature of money (Kahn et al., 2005; Garratt et al., 2021), the issuance of digital money, and financial stability. However, Eichengreen (2022) explicitly acknowledged that privacy and its legal protection, along with confidentiality as a preference of economic agents, pose serious constraints on the CBDC design choices and competition among them.

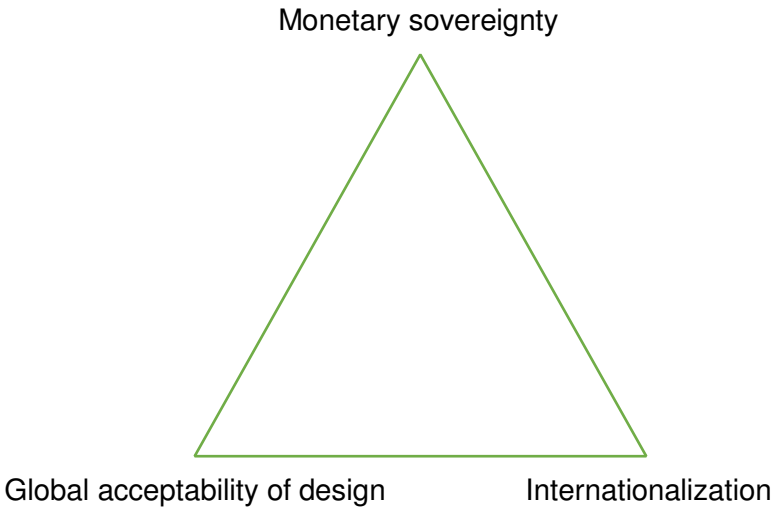
Fanti (2022) examined the context of cross-border CBDC transactions and concluded that there exists a conflict between security, privacy and performance. In other words, central banks seeking to establish mechanisms for cross-border interoperability of national CBDCs will face a trilemma of choices between design constraints, technological compatibility, and the ability to maintain security at the technical level. Put differently, variations in privacy protocols, different blockchain technology protocols, variations in cybersecurity measures or the nature of AML/KYC procedures will present serious obstacles for the effective global operation of cross-border CBDC-based circulation.

Eichengreen (2022) and Fanti (2022) have both highlighted the problem of the CBDC trilemma in an international context. Yet, this problem can be reformu-

lated to center on the compatibility between national monetary sovereignty, currency internationalization, and the global acceptability of CBDC design (Figure 1). This perspective rests on several assumptions: the competition for international currency status is intensifying and technological advantage is seen as an important prerequisite for leadership in the digital world; cross-border accessibility of CBDC plays an important role in forming an «optimal digital area»; digitalization is seen as a novel opportunity to expand or maintain the use of a particular currency in international payments, thereby enhancing its position as an invoicing currency.

Figure 1

The CBDC trilemma



Source: created by the author.

This trilemma offers the following choices:

(i) If a central bank aims to maintain domestic monetary sovereignty and promote the internationalization of its currency, it will not be able to offer a globally acceptable CBDC design. This is evident from the fact that achieving global acceptability of design may necessitate design parameters that conflict with monetary sovereignty. Ensuring the confidentiality of transactions is the simplest example. Another example involves capital mobility. If a CBDC has a globally ac-

ceptable design and is widely used for cross-border transactions between residents and non-residents, non-residents and non-residents, or residents and residents abroad, then the issuing country is poised to face challenges related to capital mobility. Several studies indicate that CBDCs in an open economy do not ensure greater stability; on the contrary, due to reduced transaction costs, they may create conditions for greater sensitivity of capital flows to interest rate differentials (Ferrari Minesso et al., 2022). Maintaining financial stability will also require additional efforts (IMF, 2020). However, CBDC designs with built-in capital flow measures (see He et al. (2023) for more details about such CBDCs) are unlikely to be in high global demand and may primarily cater to residents of the issuing country, offering better prospects for maintaining monetary sovereignty.

(ii) If a central bank opts for monetary sovereignty and is willing to propose a CBDC design that will be of interest to a wide range of non-residents, then it is unlikely to internationalize its currency. In one way or another, the expansion of CBDC circulation abroad must subordinate design considerations to attract a larger number of non-resident users. The theoretical case of the competition for the most appealing and globally acceptable design illustrates how external pressures can push the design away from what might be considered optimal for achieving internal policy goals. Moreover, such specific internal goals as social control, social scoring, or privacy intrusions are unlikely to be on the agenda when the currency is actively internationalized on the basis of CBDC. International protocols on interoperability or the application of international CBDC standards could also impose serious limitations on monetary sovereignty in what concerns the design of digital currency. Trust in the ability to guarantee the confidentiality of transactions at the design level becomes an extension of the more complex political-economic problem of dynamic inconsistency (Table 3). In the more traditional understanding of international political economy, this problem concerns the interplay between the international status of a currency and the political institutions of the issuing country.

There is another dimension to the challenge of digital currency internationalization – the response of central banks, which will seek to combat currency substitution. As shown in Edwards (2021), the introduction of a digital U.S. dollar or euro could potentially spark excessive interest in emerging markets. «Digital dollarization» could reach new heights. As part of the policy to safeguard monetary sovereignty, foreign CBDCs may face restrictions. However, implementing such restrictions poses significant challenges. While it may be feasible to restrict the use of foreign digital money for retail transactions, enforcing such restrictions becomes more difficult when it comes to payments made on cross-border platforms. Moreover, national regulators may impose restrictions or outright bans on the opening of electronic wallets in foreign CBDCs by national financial institutions, if permitted by their issuers.

Discussion

The intention underlying CBDC is more closely aligned with safeguarding monetary sovereignty under the pressure of competition from modern digital forms of money. Variables indicating the threat to monetary sovereignty, as shown in Tables 1 and 2, explain central banks' interest in promoting their own digital currencies in line with theoretical predictions. The technological capacity and financial development criteria that motivate the promotion of CBDCs are also more closely aligned with monetary sovereignty, in the sense that it is the internal goals that drive central banks in their pursuit of digital cash equivalents. However, when considering monetary sovereignty in the digital era from the perspective of openness and increased competition for international currency status, the picture changes significantly. Monetary sovereignty no longer appears absolute, for it is now positioned at the epicenter of trade-offs. The CBDC trilemma, which encompasses both internal (Bjerg, 2017; Schilling et al., 2020) and external (Eichengreen, 2022; Fanti, 2022) dimensions, underscores the fundamental role of design in shaping policy choices. The intersection of currency competition and internationalization allows us to see how monetary sovereignty can be constrained in an open economy, reproducing traditional challenges in a new digital context. In contrast to Bjerg (2017), Schilling et al. (2020), Eichengreen (2022), and Fanti (2022), the CBDC trilemma proposed in this article reflects the incompatibility between monetary sovereignty, the universal design for domestic and international purposes, and the digital-based currency internationalization. Apart from the actual conflicts of choice within the trilemma, the circulation of CBDCs abroad is likely to be a source of tension.

The internationalization of central bank digital currencies can add a new dimension to conflict situations. Once a leading central bank starts actively promoting the internationalization of its own CBDC, other central banks may feel compelled to join this competitive game. Subsequently, the competitive algorithm could drive central banks to increase their bets on proposing a more attractive design. A more attractive design could also serve to compensate for the lack of trust in political institutions in a country whose central bank promotes its own CBDC on a global scale. For this expansion to occur, however, it is necessary that the issuing central bank allows the opening of wallets in non-resident banks for non-residents and/or in resident banks for non-residents. Of course, this poses a design challenge that may conflict with internal objectives regarding the issuance of sovereign digital currency. In response, central banks may restrict the opening of cross-border CBDC wallets within their jurisdictions. On the other hand, the conflict over regulating the circulation of certain central bank digital currencies in other countries could potentially spur their issuance in more countries, as suggested by the model proposed by Cong and Mayer (2022). In such a scenario, the question of the underlying approaches to interoperability among nu-

merous national CBDCs becomes pertinent. Therefore, in the digital era, CBDCs cannot serve as an absolute solution to the issue of monetary sovereignty. Instead, they should be seen as a factor in enhancing technological adaptability in response to competitive pressures from the development of fintech, foreign CBDCs, or cryptocurrencies. This does not imply that monetary sovereignty is a losing battle for central banks. Digitization and openness limit the scope of effective monetary sovereignty, if the latter is understood as an absolute category. However, viewing it through a functional lens suggests that, without harboring unrealistic expectations about the global proliferation of national CBDCs, their circulation can be subordinated to the achievement of domestic objectives, thereby helping to preserve key aspects of national monetary sovereignty.

What practical conclusions can be drawn from the preceding discussion regarding the potential responses of central banks? One practical implication of the described competition is that not all central banks will be interested in taking the first step. Instead, it may be more advantageous for them to observe the design decisions made by pioneering central banks and consider factors such as the nature of demand, customer requirements, and technical functionality before proceeding with the design of their own CBDCs. This suggests that there may be a conditional advantage for central banks acting as last movers rather than rushing to be first movers. This approach provides a logical counterargument to the model proposed by Cong and Mayer (2022). If the costs of design changes are significant and internationalization goals are expressed, then the benefits of faster CBDC adoption in a globally competitive environment may not be as significant. Do the described scenario of CBDC competition and the corresponding trilemma mean that there are no alternative paths? Not necessarily. If central banks focus solely on internal objectives, the considerations of competition among CBDC designs fade into the background. For instance, Hernandez de Cos (2023) illustrates this with the digital euro. This static approach assumes that design decisions are ax-ante determined by internal objectives. However, this does not preclude the possibility that ex-post design changes may be prompted by shifts in the competitive environment. Therefore, central banks must remain flexible in their CBDC designs and allow for the technological possibilities of their modification. This is also an important practical implication of the debate on the dominance of internal or external objectives in CBDC adoption.

Conclusions

CBDC is a natural choice for central banks to adapt to digital transformation processes. The latter can threaten monetary sovereignty in the sense of control over the national currency. These threats manifest through various channels, including the development of private digital payment services, cross-border transactions, currency substitution, and the internationalization of certain currencies. The

threats to monetary sovereignty from the expansion of a crypto ecosystem can be traced in the relationship between the speed of CBDC adoption by central banks and indicators characterizing the development of the crypto ecosystem in a particular country. Empirical testing has revealed that progress in CBDC adoption increasingly correlates with levels of financial development and innovation within a country. However, variables indicating the expansion of the crypto ecosystem are also in a theoretically hypothesized and statistically significant relationship. While current threats to monetary sovereignty may seem somewhat exaggerated, this does not negate the possibility of their emergence in the future, given the significant impact of financial development and innovation factors.

Nevertheless, we must acknowledge that monetary sovereignty in the digital world can no longer be absolute. This shift arises from the fact that confidence in the political environment of CBDC issuers and their designs may become a product of competition, especially if central bank digital currencies are perceived as another factor in the competition for international currency status. It is only natural that the competition to attract more non-resident users may divert the design of CBDC from the internal goals of its implementation. We propose to characterize this scenario as the CBDC trilemma, where the objectives of maintaining monetary sovereignty, achieving global acceptability of the CBDC design, and facilitating its rapid internationalization appear to be simultaneously incompatible. What follows from this is the practical perspective that if CBDC issuance is primarily motivated by internal objectives, the timing of CBDC implementation is not conditional on the problem of last-mover advantages.

References

Abad, J., Nuño, G., & Thomas, C. (2023). *CBDC and the operational framework of monetary policy* (BIS Working Papers No. 1126). BIS. https://www.bis.org/publ/work1126.pdf.

Adalid, R., Álvarez-Blázquez, A., Assenmacher, K., Burlon, L., Dimou, M., López-Quiles, C., Martín Fuentes, N., Meller, B., Muñoz, M. A., Radulova, P., d'Acri, C. R., Shakir, T., Šílová, G., Soons, O., & Veghazy, A. V. (2022). *Central bank digital currency and bank intermediation. Exploring different approaches for assessing the effects of a digital euro on euro area banks* (ECB Occasional Papers No.293). European Central Bank. https://www.ecb.europa.eu/pub/pdf/scpops/ecb.op293~652cf2b1aa.en.pdf.

Agur, I., Ari, A., & Dell'Ariccia, G. (2019). *Designing central bank digital currencies* (IMF Working Paper No. 2019/252). IMF. https://www.imf.org/en/ Publications/WP/Issues/2019/11/18/Designing-Central-Bank-Digital-Currencies-48739.

Agur, I., Ari, A., & Dell'Ariccia, G. (2022). Designing central bank digital currencies. *Journal of Monetary Economics, 125*, 62–79. https://doi.org/10.1016/j.jmoneco.2021.05.002

Aizenman, J. (2019a). *Macroeconomics challenges and resilience of emerging market economies* (Working Paper 26361). NBER. https://www.nber.org/system/files/working_papers/w26361/w26361.pdf.

Aizenman, J. (2019b). A modern reincarnation of Mundell-Fleming's trilemma. *Economic Modelling*, *81*, 444-454. https://doi.org/10.1016/j.econmod.2018.03.008

Aizenman, J., Chinn, M. D., & Ito, H. (2016). Monetary policy spillovers and the trilemma in the new normal: Periphery country sensitivity to core country conditions. *Journal of International Money and Finance, 68*(C), 298–330. https://doi.org/10.1016/j.jimonfin.2016.02.008

Andolfatto, D. (2021). Assessing the impact of central bank digital currency on private banks. *The Economic Journal, 131*(634), 525–540. https://doi.org/10.1093/ej/ueaa073

Auer, R., Cornelli, G., & Frost, J. (2020). Rise of central bank digital currency: Drivers, approaches and technologies (BIS Working Paper No. 88). BIS. https://www.bis.org/publ/work880.pdf.

Auer, R., Cornelli, G., & Frost, J. (2023). Rise of the central bank digital currencies. *International Journal of Central Banking, 19*(4), 185-214. https://www.ijcb.org/journal/ijcb23q4a5.pdf.

Bjerg, O. (2017). *Designing new money: The policy trilemma of central bank digital currency*. Copenhagen Business School, CBS. MPP Working Paper. https://research-api.cbs.dk/ws/portalfiles/portal/58550948/Designing_New_Money_The_policy_trilemma_of_central_bank_digital_currency.pdf.

Bordo, M. D., & Levin, A. T. (2017). *Central bank digital currency and the future of the monetary policy* (NBER Working Paper No. 23711). https://www.nber.org/ system/files/working_papers/w23711/w23711.pdf.

Borio, C. (2019, January 11). *On money, debt, trust and central banking* (BIS Working Paper No. 763). https://www.bis.org/publ/work763.htm.

Brooks, S. (2021). *Revisiting the monetary sovereignty rationale for CBDCs* (Staff Discussion Paper 2021-17). Bank of Canada. https://www.bankofcanada.ca/2021/12/staff-discussion-paper-2021-17/.

Brunnermeier, M., James, H., & Landau, J.P. (2019). *The digitalization of money* (NBER Working Paper No. 26300). NBER. https://www.nber.org/system/files/working_papers/w26300/w26300.pdf.

Brunnermeier M. K., & Niepelt, D. (2019). On the equivalence of private and public money. *Journal of Monetary Economics, 106,* 27-41. https://doi.org/10.1016/j.jmoneco.2019.07.004

Buckley, R. P., & Trzecinski, M. (2023). Central bank digital currencies and the global financial system: The dollar dethroned? *Capital Markets Law Journal, 18*(2), 137-171. https://doi.org/10.1093/cmlj/kmad007

Chahrour, R., & Valchev, R. (2023). *The dollar in the era of international retrenchment* (NBER Working Paper No. 31405). NBER. https://www.nber.org/system/files/working_papers/w31405/w31405.pdf.

Chorzempa, M. (2021). China, the United States, and central bank digital currencies: How important is it to be first?. *China Economic Journal*, *14*(1), 102-115. https://doi.org/10.1080/17538963.2020.1870278

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

Cohen, B. J. (2006). The macrofoundations of monetary power. In D. M. Andrews (Ed.), *International monetary power* (pp. 41-75). Cornell University Press. https://escholarship.org/content/qt8xb2p5rx/qt8xb2p5rx_noSplash_4edb3639520fbfa10d1faba3bb36ab6a.pdf?t=krnd8h

Cohen, B. J. (2012). The benefits and costs of an international currency: Getting the calculus right. *Open Economies Review*, *23*, 13-31. http://dx.doi.org/10.1007/s11079-011-9216-2

Cohen, B. J. (2015). *Currency power: Understanding monetary rivalry*. Princeton University Press.

Cohen, B. J., & Benney, T. M. (2014). What does the international currency system really look like? *Review of International Political Economy*, *21*(5), 1017–1041. http://www.jstor.org/stable/24673031

Cong, L.W., & Mayer, S. (2022). *The coming battle of digital currencies* (AEP Working Paper No. 2022-04). https://www.jbs.cam.ac.uk/wp-content/uploads/2022/05/2022-ccaf-conference-paper-cong-mayer.pdf.

Doerr, S., Frost, J., Gambacorta, L., & Shreeti, V. (2023). *Big techs in finance* (BIS Working Paper No. 1129). Bank of International Settlements. https://www.bis.org/publ/work1129.htm.

Edwards, S. (2021). *Central bank digital currencies and the emerging markets: The currency substitution challenge* (NBER Working Paper No. 29489). National Bureau of Economic Research. https://www.nber.org/system/files/working_papers/w29489/w29489.pdf.

Eichengreen, B. (2011a). *Exorbitant privilege: The rise and fall of the dollar and the future of the international monetary system*. Oxford University Press.

Eichengreen, B. (2011b). The renminbi as an international currency. *Journal of Policy Modeling*, *33*(5), 723-730. http://dx.doi.org/10.1016/j.jpolmod.2011.07.004

Eichengreen, B. (2019). Two views of the international monetary system. *Intereconomics*, *54*(4), 233-236. https://www.intereconomics.eu/contents/year/2019/number/4/article/two-views-of-the-international-monetary-system.html.

Eichengreen, B. (2021, Aug 9). Will central bank digital currencies doom the dollar dominance. *Project Syndicate*. https://www.project-syndicate.org/ commentary/central-bank-digital-currencies-will-not-end-dollar-dominance-by-barry-eichengreen-2021-08.

Eichengreen, B. (2022, November 9). *The trilemma of central bank digital currencies*. Project Syndicate. https://www.project-syndicate.org/commentary/flawed-assumptions-driving-race-for-cbdcs-by-barry-eichengreen-2022-11.

Eichengreen, B., Macaire, C., Mehl, A., Monnet, E., & Naef, A. (2022). *Is capital account convertibility required to acquire reserve currency status* (CEPR Discussion Papers DP17498). https://publications.banque-france.fr/sites/default/files/medias/documents/wp892.pdf.

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/10.48550/arXiv.2202.07564

Fanti, G. (2022). An Apparent Trilemma for Cross Border Central Bank Digital Currencies. *Harvard National Security Journal, 14*(75), 75-86. https://harvardnsj.org/wp-content/uploads/2022/12/Fanti_14-Harv.-Natl-Sec.-J.-75-2022.pdf.

Farhi, E., & Maggiori, M. (2018). A model of the international monetary system. *The Quarterly Journal of Economics*, *133*(1), 295-355. https://scholar.harvard.edu/farhi/publications/model-international-monetary-system.

Fernández-Villaverde, J., Sanches, D., Schilling, L., & Uhlig, H. (2021). Central bank digital currency: Central banking for all? *Review of Economic Dynamics*, 41, 225–242. https://doi.org/10.1016/j.red.2020.12.004

Ferrari Minesso, M., Mehl, A., and Stracca, L. (2022). Central bank digital currency in an open economy. *Journal of Monetary Economics*, *127*, 54–68. https://doi.org/10.1016/j.jmoneco.2022.02.001

Flandreau, M., & Jobst, C. (2009). The empirics of international currencies: Network externalities, history and persistence. *The Economic Journal*, *119*(537), 643-664. http://www.jstor.org/stable/20485338

Floridi, L. (2020). The fight for digital sovereignty: What it is, and why it matters, especially for the EU. *Philosophy & Technology*, 33, 369-378. https://doi.org/10.1007/s13347-020-00423-6

Frankel, J. A. (2023). *Dollar rivals* (NBER Working Paper No. 31476). National Bureau of Economic Research. https://doi.org/10.3386/w31476

Frost, J., Gambacorta, L., Huang, Y., Shin, H. S., & Zbinden, P. (2019). BigTech and the changing structure of financial intermediation. *Economic Policy, 34*(100), 761-799. https://doi.org/10.1093/epolic/eiaa003

Garratt, R. J., & von Oordt, M. R. C. (2021). Privacy as a public good: A case for electronic cash. *Journal of Political Economy*, 129, 2157–2180. https://doi.org/ 10.1086/714133

Gopinath, G., & Stein, J. C. (2021). Banking, trade, and the making of a dominant currency. *The Quarterly Journal of Economics*, *136*(2), 783-830. https://doi.org/ 10.1093/qje/qjaa036

Gorton, G. B., & Zhang, J. Y. (2022). *Protecting the sovereign's money monopoly* (University of Michigan Law and Economics Research Paper No. 22-031). University of Michigan. http://dx.doi.org/10.2139/ssrn.4162884

He, D., Kokenyne, A., Mancini-Griffoli, T., Miccoli, M., Olafsson, T. T., Soderberg, G., & Tourpe, H. (2023). *Capital flow management measures in the digital age (2): Design choices for central bank digital currency* (FINTECH NOTE 2023/009). https://www.imf.org/en/Publications/fintech-notes/Issues/2023/ 09/15/Capital-Flow-Management-Measures-in-the-Digital-Age-2-Design-Choices-for-Central-Bank-538509.

Hernandez de Cos, P. (2023, November 20). *The digital euro project – a new milestone* [Speech Transcript]. Bank of International Settlements. https://www.bis.org/review/r231121i.htm

Holmström, B., & Tirole, J. (1998). Private and public supply of liquidity. *Journal of Political Economy, 106*(1), 1–40. https://doi.org/10.1086/250001

Huang, Y., & Mayer, M. (2022). Digital currencies, monetary sovereignty, and US–China power competition. *Policy & Internet*, *14*(2), 324-347. https://doi.org/10.1002/poi3.302

Iancu, A., Anderson, G., Sakari, A., Boswell, E., Gamba, M., Hakobyan, Sh., Lusinyan, L., Meads, N., & Yiqun, W. (2020). *Reserve currencies in an evolving international monetary system* (IMF Departmental Papers, No. 2020/002). https://www.imf.org/en/Publications/Departmental-Papers-Policy-Papers/Issues/2020/11/17/Reserve-Currencies-in-an-Evolving-International-Monetary-System-49864.

IMF. (2020). *Digital money across borders: Macro-financial implications* (Policy Paper No. 2020/050). International Monetary Fund. https://www.imf.org/en/ Publications/Policy-Papers/Issues/2020/10/17/Digital-Money-Across-Borders-Macro-Financial-Implications-49823.

IMF. (2021, October). Chapter 2: The crypto ecosystem and financial stability challenges. In *Global Financial Stability Report – COVID-19, crypto, and climate: Navigating challenging transitions*. Washington, DC. https://www.imf.org/en/Publications/GFSR/Issues/2021/10/12/global-financial-stability-report-october-2021.

James, H., Landau, J.-P., & Brunnermeier, M. (2019, July 3). *Digital currency areas*. VOXEU-CEPR. https://cepr.org/voxeu/columns/digital-currency-areas.

Kahn, Ch., McAndrews, J., & Roberts, W. (2005). Money is privacy. *International Economic Review*, 46(2), 377-399.

Karau, S. (2021). *Monetary policy and Bitcoin* (Deutsche Bundesbank Discussion Paper No. 41/2021). SSRN. http://dx.doi.org/10.2139/ssrn.3988527

Kenen, P. (2011). Currency internationalization: An overview. In *Currency internationalisation: Lessons from the global financial crisis and prospects for the future in Asia and the Pacific*: *Proceedings of a joint conference organised by the BIS and the Bank of Korea in Seoul on 19–20 March 2009* (pp. 9-18). BIS Papers No. 61. Bank of International Settlements. https://www.bis.org/publ/bppdf/bispap61.pdf.

Kocherlakota, N. R. (1998). *Money is Memory. Journal of Economic Theory, 81*(2), 232-251. https://doi.org/10.1006/jeth.1997.2357

Koziuk, V. (2021a). Confidence in digital money: Are central banks more trusted than age is matter? *Investment Management and Financial Innovations, 18*(1), 12-32. http://dx.doi.org/10.21511/imfi.18(1).2021.02

Koziuk, V. (2021b). Readiness to introduce digital currency: Is the central bank independence important? [in Ukrainian]. *Finansy Ukrainy*, 3, 7-22. https://doi.org/10.33763/finukr2021.03.007

Koziuk, V. (2022). What do cross-country Bitcoin holdings tell us? Monetary and institutional discontent vs. financial development. *Investment Management and Financial Innovations, 19*(1), 168-185.

Koziuk, V., & Ivashuk, Y. (2022). Does it matter for CBDC design? Privacy-anonymity preferences from the side of hierarchies and egalitarian cultural patterns. *Economics – Innovative and Economics Research Journal*, *10*(1), 35-53. https://doi.org/10.2478/eoik-2022-0008

Kreutzer, S., & Molina Vogelsang, M. (2023). Europe's digital sovereignty: An international political economy conceptual approach. In B. Herlo, & D. Irrgang (Eds.), *Proceedings of the Weizenbaum Conference 2022: Practicing Sovereignty - Interventions for Open Digital Futures* (pp. 26-38). Berlin: Weizenbaum Institute for the Networked Society - The German Internet Institute. https://doi.org/10.34669/wi.cp/4.3

Krugman, P. (1984). The international role of the dollar: Theory and prospect. In J. Bilson & C. Marston (Eds.), *Exchange Rate Theory and practice* (pp. 261-278). University of Chicago Press. https://www.nber.org/system/files/chapters/c6838/c6838.pdf.

Mancini-Griffoli, T., Martinez Peria, M. S., Agur, I., Ari, A., Kiff, J., Popescu, A., & Rochon, C. (2018). *Casting light on central bank digital currency* (IMF Staff Discussion Notes No. 2018/008). https://doi.org/10.5089/9781484384572.006

Martino, E. D. (2023). *Monetary sovereignty in the digital era* (EBI Working Paper Series 2023 No. 141, Amsterdam Law School Research Paper No. 2023-18, Amsterdam Center for Law & Economics Research Working No. 2023-07). http://dx.doi.org/10.2139/ssrn.4437723

Miranda-Agrippino, S., & Rey, H. (2020). U.S. monetary policy and the global financial cycle. *The Review of Economic Studies, 87*(6), 2754–2776. https://doi.org/10.1093/restud/rdaa019

Miranda-Agrippino, S., & Ricco, G. (2021). The transmission of monetary policy shocks. *American Economic Journal: Macroeconomics, 13*(3), 74–107. 10.1257/mac.20180124

Murau, S., & van 't Klooster, J. (2022). Rethinking monetary sovereignty: The global credit money system and the state. *Perspectives on Politics, 21*(4), 1319–1336. https://doi.org/10.1017/S153759272200127X

Naef, A., Monnet, E., Macaire, C., Mehl, A., & Eichengreen, B. (2022, Oct 31). *The renminbi's unconventional route to reserve currency status*. VOXEU-CEPR. https://cepr.org/voxeu/columns/renminbis-unconventional-route-reserve-currency-status.

Panetta, F. (2022, June 15). *The digital euro and the evolution of the financial system* [Speech Transcript]. European Central Bank. https://www.ecb.europa.eu/press/key/date/2022/html/ecb.sp220615~0b859eb8bc.en.html.

Panetta, F. (2023, June 23). *Paradise Lost? How crypto failed to deliver on its promises and what to do about it* [Speech Transcript]. European Central Bank. https://www.ecb.europa.eu/press/key/date/2023/html/ecb.sp230623_1~80751450e6.en.html.

Prasad, E. (2023). How will digital technologies influence the international monetary system? *Oxford Review of Economic Policy*, 39(2), 389-397. https://doi.org/10.1093/oxrep/grad011

Raskin, M., & Yermack, D. (2016). *Digital currencies, decentralized ledgers, and the future of central banking* (NBER Working Paper No. 22238). https://doi.org/ 10.3386/w22238

Rey, H. (2013, August 21-24). Dilemma not trilemma: The global financial cycle and monetary policy independence. In *Global dimensions of the unconventional monetary policy: Jackson Hole Economic Policy Symposium* (pp. 285-333). Federal Reserve Bank of Kansas City. https://www.kansascityfed.org/ Jackson%20Hole/documents/4575/2013Rey.pdf.

Rey, H. (2016). International channels of transmission of monetary policy and the Mundellian trilemma. *IMF Economic Review, 64*(1), 6–35. https://doi.org/10.1057/imfer.2016.4

Schilling, L., Fernández-Villaverde, J., & Uhlig, H. (2020). *Central bank digital currency: When price and bank stability collide* (NBER Working Paper. No. 28237). NBER. https://www.nber.org/system/files/working_papers/w28237/w28237.pdf.

Schnabel, I., & Shin, H. S. (2018, February 6). *Money and trust: Lessons from the 1620s for money in the digital age* (BIS Working Paper No. 698). BIS. https://www.bis.org/publ/work698.htm.

Soderberg, G., Kiff, J., Tourpe, H., Bechara, M., Forte, S., Kao, K., Lannquist, A., Sun, T., & Yoshinaga, A. (2023, September 8). How should central banks explore central bank digital currency? *FinTech Notes, 2023*(008), 1-43. https://doi.org/10.5089/9798400253768.063

Tobin, J. (1969). A general equilibrium approach to monetary theory. *Journal of Money, Credit and Banking, 1*(1), 15–29. https://doi.org/10.2307/1991374

Tucker, P. (2017, June). *The political economy of central banking in the digital age* (SUERF Policy Note, Issue No. 13). The European Money and Finance Forum. https://www.suerf.org/wp-content/uploads/2023/12/f_af21d0c97db2e27e13572cbf59eb343d_1105_suerf.pdf.

UK Parliament (2023, January 17). *Central bank digital currency: A solution in search of a problem?* (3rd Report of Session 2021-22; HL Paper 131). Economic Affairs Committee. https://publications.parliament.uk/pa/ld5802/ldselect/ldeconaf/131/13102.htm.

Waliczek, S. (2023). *Central bank digital currency global interoperability principles* [White Paper]. World Economic Forum. https://www3.weforum.org/docs/WEF_Central_Bank_Digital_Currency_Global_Interoperability_Principles_2023.pdf.

Zhu, Yu., & Hendry, S. (2019). *A framework for analyzing monetary policy in an economy with e-money* (Staff Working Paper 2019-1). Bank of Canada. https://www.bankofcanada.ca/2019/01/staff-working-paper-2019-1/

Zimmermann, C. D. (2013). The concept of monetary sovereignty revisited. European Journal of International Law, 24(3), 797-818. https://doi.org/10.1093/ejil/cht041