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The future of the international financial system: The emerging CBDC network and its impact on regulation

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Abstract

Central bank digital currency (CBDC) is a digital form of fiat currency. CBDC has the potential to be a game challenger in the international financial system, bringing increased complexities arising from technology and regulatory considerations, as well as generating greater currency competition. As more states begin exploring CBDC, the interactions between actors may lead to the emergence of a new CBDC network. What shape would the emerging CBDC network take? What would its network effects be? What would be the impact of the CBDC network on the international financial system, or the global financial network? This article explores these questions by examining the emerging CBDC network and its regulatory implications. It argues that the CBDC network would likely be both decentralized and uncoordinated, making it unlikely to lead to convergence in CBDC regulation. The CBDC network would probably bring policy diffusion effects, with states behaving instrumentally, while shaking up the power balance between different actors, generating both cooperation and conflict. The CBDC network also has the potential to push international financial system toward becoming more decentralized.

Keywords: central bank digital currency, international financial system, network, regulation, technology.

1. Introduction

Central bank digital currency (CBDC), a digital form of fiat currency, is quickly becoming a reality. As of July 2022, two CBDCs have been fully launched and almost 100 CBDCs are in various phases of experimentation or research (such as proof of concepts) (Stanley, 2022). Technological developments and the far-reaching effects of digital expansion (Latour, 2011, p. 800), financial disruptions, the response to COVID-19, stablecoin development, and China's CBDC pilot have brought CBDC into sharper focus for central banks (Brett, 2020). More economies, including the European Union and the United States, are investing in CBDC research or planning.

The introduction of CBDC has the potential to be a game challenger for the international financial system. CBDC is moving into the global arena and will likely shape the next evolution of money (Mancini-Griffoli et al., 2018, p. 30). The rise of CBDC and private cryptocurrencies (e.g., stablecoins and Bitcoin) will lead not only to greater currency competition (Yao, 2018b), but to increased regulatory complexities ranging from data-related issues to financial stability. As CBDC comes to be used in international and cross-currency payments (Bank of Canada et al., 2020, p. 7), commentators have predicted that current "borders of economic influence [will] no longer … be contained by political borders" (Yeung, 2020). The development, management, and use of CBDC will necessitate a great degree of interaction between states in numerous aspects (e.g., CBDC

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interoperability, and the prevention of financial crimes). According to the Bank for International Settlements (BIS), 28% of surveyed central banks are contemplating options to "make CBDCs interoperable by forming multi-CBDC arrangements" (Auer, Boar, et al., 2021, p. 1).

States can be expected to form a CBDC network (Carney, 2019, pp. 14, 15), connecting CBDC-issuing central banks as actors (nodes) in the network. Arguably, a CBDC network would form part of the global financial network (GFN) that involves a currency network and an international network among financial regulators (Lopez, 2021, p. 184). This echoes the fact that finance is "one of the most—if not the most—globalized and networked of human activities" (Wójcik, 2018, p. 272) given the interdependence of financial systems (Coe et al., 2014, p. 763). The international currency system, for instance, has network characteristics (Knoerich, 2021, p. 158).

This article seeks to contribute to the literature on money and finance by utilizing network analysis to explore what kind of CBDC network is likely to emerge as well as its network effects and its impact on international financial system or the GFN. Network analysis examines what is happening and enables predictions as to network creation and development, as well as the investigation of networks' impacts on actors' behaviors (Hafner-Burton et al., 2009, p. 563). Network perspectives allow analysis of the relationships among actors to determine the structure of the network over its life cycle and the network's effects on actors (Egelston et al., 2019, p. 3). While many factors remain up in the air, this article provides a hypothetical and forward-looking application of network theory to the prospect of the introduction of CBDCs by various jurisdictions. Networks may drive interactions in regulatory governance (Eberlein et al., 2014, p. 9), while network theory helps us to explore inter-organizational relationships (Eberlein et al., 2014, p. 4) and understand dynamics in transnational governance (Porter, 2014, p. 114). However, this article does not argue that network analysis explains every aspect of CBDC. Instead, other approaches (such as theories of interactive governance, transnational governance, and regulatory governance), while outside this article's scope, may offer valuable contributions. We hope that network analysis would support other approaches and inspire further CBDC research.

This article focuses on relationships among central banks in the CBDC network and GFN. While the influence and position of central banks in the GFN have been under-researched, they currently play the leading role in CBDC. Critically, CBDC is issued by a central bank rather than the private sector. One may argue that CBDCs reflect the resurgence of states in finance and are a response by central banks to private cryptocurrencies that affect their power. Central banks design, issue and regulate CBDC. CBDC is backed by states and relies on a high level of nodes (central banks or the like) to support its cross-border use. Therefore, this article focuses on economies whose central banks or the like are to issue or may consider issuing CBDC. For the GFN, the role of the state in the network has been underappreciated (Lai & Samers, 2021, p. 727), despite power and governance being "major concerns at [its] very conception" (Wójcik, 2018, p. 273). More broadly, there are calls for more theorization of the state's role in the development of the GFN (Töpfer, 2018, p. 252). Accordingly, this article examines the potential influence of central banks and the emerging CBDC network on the GFN more broadly.

The article does, however, note how other actors, such as commercial banks (Lastra, 2015, pp. 25–26) and international organizations, may interact with central banks. This understanding of the CBDC network here may serve as a basis for analyzing the role of private actors and international financial centers in the future. International organizations, like the BIS, could promote collaboration and provide valuable platforms for cooperation. However, given their nature, international organizations are currently limited in their role in CBDC development. Divergent domestic dimensions and considerations of CBDC make any international consensus difficult to attain. Current projects involving international organizations appear to cover limited aspects of CBDC, including how cross-border use of CBDC may work technically or sharing experiences from projects. While this article considers the potential coordination role of such international organizations, its primary focus is relationships among central banks. The article focuses on the interactions between these actors rather than domestic interactions such as currency issuance that has attracted substantial attention in literature. Such a focus on central banks and their interactions help us to explore how the introduction of CBDCs could be expected to play out in the international financial system.

The article is designed to address the limits of existing data and experiences with CBDC (Kiff et al., 2020, p. 5). Based on extensive textual analysis, this article combines analysis of policy documents and secondary literature with insights drawn from social network literature to hypothesize about the likely properties of a CBDC

network. This forward-looking analysis fills gaps in the research of central banks' interaction regarding CBDC to identify potential challenges and explore solutions.

The article proceeds as follows. Section 2 explores the form a CBDC network may take, including the nodes, ties, and network structure. Section 3 explores the profound effects of the CBDC network on regulation: policy diffusion, as well as cooperation and conflict. Section 4 argues that while CBDC network could push the international financial system toward becoming decentralized, it is uncertain whether the GFN will shift to a flat one. Section 5 concludes with observations on the future of the international financial system. We note that this article does not aim to analyze the merits of CBDCs, which deserve separate and careful analysis.

2. The CBDC network

As indicated above, the adoption of CBDC may lead to the emergence and development of a network of states. A network consists of nodes connected by ties which form a network structure, where nodes take positions in the structure (Borgatti & Halgin, 2011, p. 1169). Network theory examines the processes interacting with network structures that produce outcomes and also traces the network's evolution, including its ties (Borgatti & Halgin, 2011, pp. 1168–1169). The major object of network theory is to explore how a network's properties develop and the consequences of those changes (Borgatti & Halgin, 2011, pp. 1169–1170, 1177). Accordingly, this part explores the following crucial questions: what are the potential nodes, ties, and structure of the CBDC network? Would the CBDC network take the shape of networks-as-actors or networks-as-structures? Based on a review of CBDC designs and considerations, we conduct network analysis to theorize possible structural developments and dynamics (Oatley et al., 2013, pp. 137, 148).

2.1. CBDC technical designs and regulation

CBDC represents a liability of a central bank (Bank for International Settlements, 2018, p. 3), distinguishing it from private money (e.g., commercial bank liabilities) and private cryptocurrencies (Bossu et al., 2020, p. 7).

CBDCs can adopt different technical designs, and central banks will need to make decisions on at least three key aspects. First, whether to adopt (i) an account-based CBDC, an account at the issuing bank for the public, or (ii) a token-based CBDC, "digital cash" issued by the central bank that may offer greater user anonymity (Barontini & Holden, 2019, p. 2). Second, whether they will develop a retail account for day-to-day use (Lowe, 2017: 9), or a wholesale CBDC issued to participants like clearing banks and public bodies (Bossu et al., 2020, p. 9). Third, whether the CBDC will be single-tiered, meaning central banks directly issue CBDC to the public and operate all aspects of the CBDC system, or a two-tiered system, where central banks rely on intermediaries (e.g., commercial banks) to issue CBDC and interact with customers (Richards et al., 2020, p. 35).

A CBDC's legal treatment would hinge on its design features (Bossu et al., 2020, pp. 5, 9, 41). For instance, charging interest on CBDC is more feasible for an account-based CBDC than for a token-based one. As tokens represent a unique relationship between the holder and the central bank, not being a loan disguised as a deposit, there is no loan on which to pay interest (Bossu et al., 2020, p. 37). Equally, complete anonymity is feasible for a token-based CBDC, but not for an account-based CBDC (Richards et al., 2020, p. 36). The varying nature of CBDC designs will necessitate variation in the regulatory frameworks developed around CBDC, which in turn affect the structure of the CBDC network as discussed below.

2.2. The nodes, ties, and structure of the CBDC network

An increasing number of economies are exploring CBDC with different motivations, as discussed below. As of late 2020, 86% of central banks were undertaking CBDC work (Boar & Wehrli, 2021, p. 6). The development of CBDC will require a great degree of interaction among central banks, such as the interoperability of CBDCs in international and cross-currency payments. These interactions will likely give rise to the CBDC network, connecting each CBDC-issuing central bank as nodes within the network.

Three factors are crucial in applying network theory to CBDC and the practices of states so far: (1) the number of nodes, (2) how often those notes interact or the network's "density," and (3) the network's structure (Lake & Wong, 2009, p. 129).

2.2.1. Nodes

The CDBC network will likely begin with a small number of nodes as central banks incrementally come to issue CBDCs. The current national attitudes toward CBDC can be divided into three groups: supportive, mixed (wait and see), and against. Only a few states are explicitly against issuing CBDC at the time of writing, including Denmark, which considers its costs as exceeding its benefits (Auer & Böhme, 2020, p. 97), and Ecuador, whose previous Dinero Electrónico project failed to attract enough users given a lack of trust in its central bank (Auer et al., 2020, p. 5; O'Neal, 2018). Most states, however, have adopted more supportive or mixed attitudes.

CBDCs have been introduced into several smaller economies (e.g., Bahamas, Lithuania). China is likely to be the first major economy to issue a CBDC, having been piloting CBDC since 2020 and conducting research of CBDC since 2014 (Yao, 2018a, pp. 175, 176; Wang, 2022, p. 81). Among developed states, Sweden started pilot testing its e-Krona in 2020, and "probably is the closest developed economy to actual launch" (Didenko et al., 2020, p. 20, footnote 78). The drivers for CBDC range from financial inclusion to the response to stablecoins (see, e.g., Sytas, 2021). These states that have embarked on pilots are likely to constitute the initial nodes within the CBDC network.

As for later entrants, a large number of economies have evinced a wait-and-see attitude, attributable to, inter alia, regulatory challenges, concerns that the technology itself is insufficiently innovative to form a worthwhile investment, or apprehension over a CBDC's financial effects (O'Neal, 2018). Canada and England have indicated the need for multi-year research before a decision about adopting a CBDC is made (Ahmat & Bashir, 2017, p. 2; Bank of England, 2021; Reuters Staff, 2021a). Elsewhere, Japan, the United States, and the United Kingdom are moving toward analyzing the technical implementation and policy implications of CBDC in their specific circumstances (Bank of Japan, 2020, p. 19). For instance, Japan's central bank has initiated one-year CBDC experiments in 2021 to test the feasibility of a CBDC (Reuters Staff, 2021b).

Overall, the number of nodes in the CBDC network will likely increase over time given, inter alia, currency competition and network benefits. Once states see others introducing their CBDC, they may be expected to advance their own development of a CBDC. This could be driven by currency competition concerns or the desire to access possible network externalities, like the efficiency benefits of CBDC. CBDC could be used internationally due to its benefits and potentially streamline international payments (Wood, 2019; Wang, 2023 forthcoming, p. 8). As discussed below, the potential network benefits that may make CBDC attractive may not transmit or may be limited to network clusters (i.e., groups of nodes). Nodes would interact and form ties that shape the network structure. The drivers of interactions include nodes' "interests, values, perceptions, knowledge, resources, and the legal and operational limits," whose alignment promotes cooperation while misalignment can cause potential conflict (Eberlein et al., 2014, p. 9). It is possible that "actors deliberately shape the networks around them for their benefit," and as such, examining the interaction between the network position of a node and nodes' attributes (e.g., motivations, capacities) is crucial (Borgatti & Halgin, 2011, pp. 1177–1179). The network structure and a node's location within it, as discussed later, carry implications for individual nodes (Borgatti & Halgin, 2011, pp. 1170, 1173).

2.2.2. Ties

Ties within the CBDC network would be the relationships among actors, and, as in other networks, reflect the frequency of interactions between nodes and the density of the network (Elkins, 2009, p. 46). That said, nodes are not necessarily all connected with each other, particularly at the early stage of network evolution (Borgatti & Halgin, 2011, p. 1169).

Ties could take wide-ranging forms, which are often shaped by structural interdependencies of states (Kostoska et al., 2020, p. 2) and involve negotiation (Whittle & Spicer, 2008, p. 620). Actors would likely tradeoff the costs and benefits of establishing and maintaining a tie (Bala & Goyal, 2000, p. 1181). Forms of ties include central bank currency swap agreements, linkages in foreign exchange systems, memoranda of understanding (MOUs) on fighting financial crimes (e.g., money laundering and the financing of terrorism), information exchange agreements, trade settlement programs, offshore clearing, and foreign currency debts (Carney, 2019, pp. 11, 13). Ties also include being comembers in organizations and co-participating in events that may feature frequent interactions between nodes (Borgatti & Halgin, 2011, p. 1170). Essentially, ties may "emerge from the strategic choices of agents" (Cao & Ward, 2017, p. 78) and help to explain the connectedness of nodes. Different ties also have different effects on network relationships. For example, bilateral MOUs may better promote direct network relationships compared to network membership in general (van der Heijden & Schalk, 2020, p. 775).

Ties could be affected by the position of states in the GFN and the roles associated with these positions. A node's location within networks and its particular attributes influence the likelihood of tie formation (Hafner-Burton et al., 2009, pp. 566–567). For CBDC, such attributes would likely include technological capacity and domestic governance. A node may have a positional advantage if its potential partners lack alternative ties (Borgatti & Halgin, 2011, p. 1173). To make the best use of the tie's utility, actors may change their ties over time based on the evaluation of their positions in a network (van der Heijden, 2021, p. 7). It is useful to observe the ties formed, any central actors, and the potential characteristics of a network over time (Borgatti & Halgin, 2011, p. 1168).

Ties in the CBDC network would likely involve new issues, particularly interoperability among national CBDC systems, CBDC and non-CBDC system interoperability (e.g., payment systems), a possible interchange mechanism between a foreign CBDC with local currency (SWIFT & Accenture, 2021, pp. 8, 12), and CBDC-related data flow. In this process, central banks would also rely on existing interconnections, including significant cross-border financial flows, and membership in international organizations or forums. Ties in the CBDC network may follow other networks where ties can be "symmetrical or … stronger in one direction than the other" (Hafner-Burton et al., 2009, p. 563).

The tie's strength depends on both the magnitude and frequency of interactions between two nodes (Hafner-Burton et al., 2009, p. 563). Accordingly, such ties in CBDC network will largely depend on the size of its interactions, being financial flows, between nodes, like trade networks which are comprised of economic exchanges (Zhou, 2020, p. 589). To illustrate, if a CBDC becomes the major foreign exchange reserve of many other countries, more ties are likely to occur with this issuing state. A node joining a group may also exhibit trait similarities which may gradually affect network structure (Borgatti & Halgin, 2011, p. 1170). The measuring of the ties "defines a network" (Borgatti & Halgin, 2011, p. 1170). Measuring financial flows between nodes (e.g., quantity, direction, timing, trend) is then a useful way to understand the ties and structure of the network.

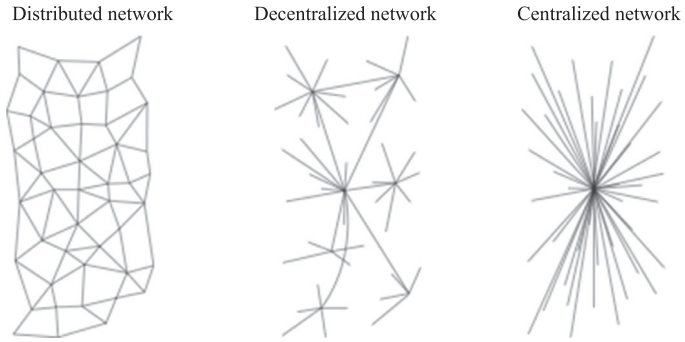
Ties will in turn influence how policy diffusion processes proceed (which will be discussed in Section 3.1) and affect relational structures in the network and network evolution (van der Heijden & Schalk, 2020, p. 782). Ties can be pipes that act as conduits to transfer resources or bonds which create close coordination (Borgatti & Halgin, 2011, pp. 1174–1177). Ties between CBDC nodes would serve as channels for the transmission of material (currency) and non-material or social products (e.g., information and rules), and, like other networks, may create continuous models of association among nodes to develop structures that will, in turn, affect the nodes' behaviors (Hafner-Burton et al., 2009, p. 562). Ties might align the actions of some nodes and even allow "groups of nodes to act as a single node, often with greater capabilities" (Borgatti & Halgin, 2011, p. 1173).

Ties could divide a network into subgroups (like clusters) (Hafner-Burton et al., 2009, p. 565), as discussed below. Nodes forming ties could demonstrate homophily, due to common attributes, or heterophily, to minimize weaknesses and share strengths (Hafner-Burton et al., 2009, pp. 567–568).

2.2.3. Network structure

We predict the CBDC network is likely to be a decentralized network. A network's structure can be assessed by considering centrality ranging from distributed to centralized networks (as depicted in Fig. 1). For a distributed network, most nodes have the same number of links, it being rare to have many or few links (Lake & Wong, 2009, p. 129). A distributed network does not have a central actor (Buocza et al., 2019, p. 184), and could be a kind of lattice "with each node connected to its neighbors" (Lake & Wong, 2009, p. 129). A distributed network (like the Internet or Bitcoin; Buocza et al., 2019, p. 184) is less efficient but has the advantage of enhanced resilience where the network is not reliant on ties with a single node (Sheng, 2010, p. 4). However, CBDC nodes are not likely to have the same number of links because of countries' varying positions in the GFN (as discussed below) and the perceived performance of CBDCs.

In a centralized network, one or more states, or central banks in the case of CBDC, sit in a more central place than others (Sarpong & Deodutt, 2019, pp. 1, 25). A centralized network structure typically has a center-periphery attribute, under which one actor is ensconced at the center and all other actors are on the periphery (Oatley et al., 2013, pp. 135–137). Centralized networks have arguably the most efficient network structure, but they are also most vulnerable if the hub fails (Sheng, 2010, p. 4). The CBDC network is not likely to be a centralized network as it is not obvious which central bank would take such a central position in this context. For



Source: Adapted from Andrew Sheng, Financial Crisis and Global Governance: A Network Analysis, COMMISSION ON GROWTH AND DEVELOPMENT WORKING PAPER NO. 67 (Sheng 2010, p. 4 (with slight adaptation of the original figure)).

Figure 1 *Source*: Adapted from Sheng (2010), p. 4 (with slight adaptation of the original figure).

instance, the United States appears to be a long way from introducing a CBDC, and China's position in the GFN is still developing.

In the middle of the network structure continuum sit decentralized networks, which consist of clusters. A decentralized network has "a relatively small number of central nodes" (Buocza et al., 2019, p. 184), and these nodes are probably central more for respective clusters than for the whole network. In a decentralized network, two nodes are grouped if they have dense direct ties ("cohesive subgroups") or share similar ties to other nodes ("structurally similar clusters") (Hafner-Burton et al., 2009, p. 565).

The CBDC network would probably be a decentralized network. As the backdrop for CBDC, the digital age is "fragmenting the playing field between governance actors" (Zwitter & Hazenberg, 2020, p. 2). Instead of forming around established central actors, clusters are likely to be formed by countries with similar interests or structural positions in the CBDC network. Cluster membership could bring economic advantages (such as interoperability) that cannot be fully enjoyed by non-members (Bilotta, 2021, p. 178). A group of states may affect the standard development in other states by denying access to such a "club" to states that fail to meet their rules, and such exclusion would incentivize membership to reap the benefits of joining a cluster (Bilotta, 2021, p. 177).

Currency blocs might arise if nodes share similar interests, where states may choose one common CBDC for international and even domestic transactions (Zhang, 2021). Under structural equivalence, a prominent relational mechanism in network analysis, alike nodes are likely to take similar actions (Hafner-Burton et al., 2009, p. 567). CBDC clusters may arise due to structural positions that may evolve through developments such as responses to tensions or sanctions. Some states, for these reasons, may want to pursue a decentralized international financial system and reduce their reliance on the dollar. For these states, CBDC could enable direct payments between states, bypassing US-dominated systems (Nelson, 2022). The revolutionary nature of CBDC may allow states to develop new systems, rather than reforming the status quo (Liu & Papa, 2022, p. 16). CBDCs accepted by a cluster of these states may become possible "nondollar club goods" (Liu & Papa, 2022, p. 16). New regional reserve currencies may emerge in these clusters (Committee on Payments and Market Infrastructures, et al., 2021, p. 18).

Affected by political economy, technology, and other factors, the structure of and interactions within clusters would evolve in a decentralized CBDC network. A network, rather than being predetermined, "'writes' itself … by continually recombining the individual 'nodes' and their relationships" (Ladeur, 1997, p. 48). In practice, actors often consider or even imitate the actions of like parties facing complex choices (Elkins, 2009, p. 55). Actors are likely to have a preference to work with actors with similar characteristics, like administrative tradition or market size, or actors with closer links given high volume capital or trade flows (van der Heijden 2021, pp. 5–6). For example, states with advanced digital payments and declining cash use may prioritize maintaining "a public sector-provided means of payment," while states with lower penetration of digital payments may be driven by financial inclusion concerns (Auer et al., 2020, p. 28).

That said, it is too early to tell how clusters would form and how they would be linked to one another. These clusters may not necessarily interoperate with each other via hubs. Such links would also be affected by the digital infrastructure of states, their technological innovation, and legal arrangements (Auer et al., 2020, p. 12), let alone traditional issues like geopolitical tensions. To illustrate, CBDC projects of central banks are divergent in many aspects (e.g., motivations, plans, strategies, rules, and standards), and may seriously affect the interoperability among CBDCs (Zamani et al., 2021, p. 3).

From another perspective, there are centralized (or hierarchical, hegemonic) networks and flat (or multipolar) networks, distinguished by reference to how influence is distributed. In flat structures, no actor is "substantially more central" than others (Oatley et al., 2013, pp. 135–137). A flat network could consist of several parts in which certain actors are less connected with one part than others (Avant & Heger, 2013, p. 4), but actors are interconnected to more or less a similar extent (Oatley et al., 2013, p. 147). Depending on the actual network, actors in a flat system could be thinly or densely connected (Avant & Heger, 2013, p. 4). With no obvious central node yet to emerge, the CBDC network would likely be closer to a relatively flat, multipolar network.

2.3. The form of the CBDC network: Networks-as-actors versus networks-as-structures

Networks can also be classified into two, distinct forms: (i) networks-as-actors, where networks are conscious, "thick intentional networks that are simultaneously both structures and agents" who "act collectively to further specific goals"; and (ii) networks-as-structures, where networks are considered unintentional, "thinner, uncoordinated networks that only exist as structures" (Elkins, 2009, p. 47; Sikkink, 2009, pp. 229, 235).

For networks-as-actors, networks are a form of international governance among key actors (Hafner-Burton et al., 2009, p. 561). One may argue that the international monetary system shaped by the Bretton Woods conference largely took a network-as-actor form. The Bretton Woods conference "instituted a world system where the US dollar was at the centre of the global economy; the value of a nation's currency was determined in relation to the US dollar," with international transactions often being denominated in dollars (Thomas et al., 2017, p. 106).

Regarding networks-as-structures, the behavior of actors is uncoordinated (Elkins, 2009, p. 46). The relational structures and emergent attributes of the network shape the actions of its nodes (Kahler, 2009, p. 4). Networks, as "sets of relations that form structures," may both limit and empower actors and influence the broad environment (e.g., agreements among states) and international outcomes (Hafner-Burton et al., 2009, pp. 560, 61). Networks-as-structures affect the actors' behavior in the networks, which will, in turn, bring network effects (Kahler, 2009, p. 4). For networks-as-structures, the key is how actors respond in the context of their ties and the network structure and its characteristics, instead of the collective behavior of all actors (Elkins, 2009, p. 46).

The CBDC network is likely to have elements of both networks-as-actors and networks-as-structures, as most networks do (Sikkink, 2009, pp. 228–229, 232, 245). The clusters in the CBDC network may be close to networks-as-actors in the sense that different clusters may have their own voices and promote their own goals. However, the whole CBDC network would in all likelihood not resemble a network-as-actor, since all actors would be unlikely to promote specific common goals given the substantial variation in actors' considerations, needs, and values. Even if the parties intend to promote international transactions, a considerable difference exists in states' attitude in crucial aspects such as data flow and privacy.

As such, the CBDC network as a whole would probably more closely resemble a network-as-structure, although its clusters may be closer to networks-as-actors. The design of the CBDC network as a whole cannot be expected to be intentionally undertaken by any actor(s). The CBDC network would thus lack an arrangement like that under the Bretton Woods system but instead resemble a looser network without a strong central node, constraining its capacity to engage in coordinated action (Lake & Wong, 2009, p. 149). While certain coordination is necessary to allow for cross-border transactions, it is likely that the fundamental divergence in the considerations and approaches of differing economies to a CBDC, among other factors, may limit collaboration and collective action.

3. The network effects: Implications for CBDC regulation

Network theory works to "explicate the connection between structure and outcome," including the effects of network structure (Borgatti & Halgin, 2011, p. 1172). This part builds on the network structure analysis and reflects on the network's regulatory effects, which would determine how actors conduct their relationships and what regulation needs to pay attention to. In so doing, we consider the implications of the CBDC network for regulation, particularly by policy diffusion, conflict, and cooperation.

3.1. Policy diffusion: Uncoordinated interdependence

The CBDC network could bring the diffusion of CBDC regulation, but not necessarily convergence. Policy diffusion occurs when one state's policies are influenced by another's (Gilardi & Wasserfallen, 2019, p. 1245), and is often uncoordinated but interdependent (Elkins, 2009, p. 46). Policy diffusion includes learning and adaptation. Learning occurs when another's adoption of a policy "imparts information (thus implying functional motives for imitation)," while adaptation occurs when another state's such adoption "alters the value of the practice (thus implying instrumental motives for imitation)" (Elkins, 2009, pp. 47–48, 61). A central bank adopting CBDC may impart lessons for other central banks and alter approaches to CBDC regulation.

3.1.1. Learning

The CBDC network may facilitate the learning processes of different economies, although such a process would face serious challenges. The network of relationships is essentially "an information repository" which signals to actors who to develop relationships with (van der Heijden 2021, p. 2). Central banks are closely watching CBDC development, including implementation and regulation by other jurisdictions, as a way to learn from others' experiences. States are likely to be unsure of what position to take on various CBDC-related issues, due to the limited available information and uncertainty of outcomes (Eilstrup-Sangiovanni, 2009, p. 207). This requires that actors gather wide-ranging knowledge. From a technical perspective, learning is needed regarding solutions to encryption challenges, risk control measures to protect data privacy and security, amendments regarding flawed transactions, and contingency plans in the case of system failures (Zhou, 2020). For regulation, CBDC issuance and wide circulation would necessitate changes to many systems, including payments infrastructure and settlement finality, privacy and data protection law (Bossu et al., 2020, p. 5). The regulation of CBDC, when compared with paper currency, would apply to an even wider range of actors, including data service suppliers, firms maintaining CBDC applications, and suppliers of point of sale devices to initiate and accept payments (Bank of Canada et al., 2020, p. 4).

Networks may, if properly managed, supply information and promote learning (Hafner-Burton et al., 2009, p. 573), which can then inform actors' decisionmaking. If links between two nodes are lacking, they could be contacted by a shared third-party node serving as "indirect channels for information" (van der Heijden 2021, p. 5). Learning could happen via institutionalized and ad hoc forms, including working groups and conferences (e.g., G7 Working Group on Stablecoins). Forms of learning could range from the identification by actors of the challenges and implications of CBDC, to information sharing on best practices. The International Monetary Fund (IMF) has also promoted peer-learning activities concerning CBDC (IMF, 2022).

However, learning may not be smooth given problems faced by the flow of information. Access to information itself could be challenging, and a policy's availability may distort learning (such as giving disproportionate weight to more prominent nations' policies) (Elkins, 2009, pp. 53–55). Given the vital role of the monetary system and the often-sensitive nature of financial technology, states might consider the relevant technology and data to involve national security issues. Further, learning is affected by a node's position in the network, and access to information will often depend on the existence of a link between a given node and other nodes. Even if a link exists, the time for "information or resources to propagate to a given node in a network" will be affected by the length of the path between a node and other nodes (Hafner-Burton et al., 2009, p. 564). Nodes with "high closeness or information centrality" obtain information quicker than others (Hafner-Burton et al., 2009, pp. 568–69), and there are questions as to "the likelihood of information passing along particular ties (proportional to their strength)" (Hafner-Burton et al., 2009, p. 565). For instance, smaller states may not have many direct connections with larger states or may encounter resource limitations like capacity limits.

Information may be manipulated (Lake & Wong, 2009, p. 131) or face limitations and create biases in the learning given the difficulty of assessing the applicability of another country's models, the inability to observe long-term trends (Elkins, 2009, pp. 53, 54), and the insufficient supply of credible information (Kinne, 2013b, p. 781). In the same vein, an early failure of a project may lead others to reject like projects, while less "available" case studies, like "[l]ong-term trends or low-profile cases," are likely to have "less of an impact" (Elkins, 2009, p. 55).

Learning will be crucial to the ongoing development of CBDC, with technical designs and regulation still in the early stages. The CBDC network would bring with it a competition of ideas in technical design and regulatory approaches. These ideas include one-tier or two-tier CBDC, the use or not of blockchain in CBDC (see, e.g., John, 2020), and different distributed ledger technology (DLT) platforms for CBDC (SWIFT & Accenture, 2021, p. 14).

Various ideas will likely compete for acceptance in the network, given the difficulty of determining a norm's quality before it is manifested in practice (Lake & Wong, 2009, p. 128). The challenges associated with learning, including the prioritization of policies adopted by powerful states and the difficulties in sharing information may, however, have an overall negative impact on the network utility as a learning tool.

3.1.2. Adaptation

Adaptation is likely to arise as a CBDC network effect. Under adaptation, a decision to adopt a policy changes "the utility of the policy for others" and produces externalities that will be considered by latecomers (Elkins, 2009, p. 49). Central banks issuing CBDCs can be expected to develop their own policies. However, one central bank's adoption of a CBDC would affect other central banks' attitudes toward a CBDC given various factors like currency competition and network externalities. In particular, a major central bank's decision to adopt a CBDC would change the conditions in which other central banks make their choices.

Due to adaptation, states in the network may behave instrumentally, wherein they are "less focused on the direct benefits of the policy itself," but consider other elements like the effects on the competitive equilibrium and their international competitiveness (Elkins, 2009, pp. 49, 51).

For the elements of competitive equilibrium and the competitiveness at the international level, commentators predict that monetary competition between major economies' CBDCs and cryptocurrencies "will be the defining development of the next decade" (Didenko et al., 2020, p. 5). CBDC could also potentially affect currencies' international role (Auer et al., 2020, p. 3). François Villeroy de Galhau, the Governor of the Bank of France, indicated that he sees "a certain interest to move quickly on the issue of at least a wholesale [CBDC] to be the first issuer at the international level and thus derive the benefits reserved for a reference [CBDC]" (Raghuveera & Bray, 2020). Resembling other networks, there are likely first-mover advantages concerning CBDC facilities, due to the leverage essential facilities can provide over other actors (Cowhey & Mueller, 2009, p. 180). The leading nations issuing CBDC may export their technology to other countries and have impacts on standard setting. There are also network externalities such as international payment efficiency (Auer, Haene, & Holden, 2021, p. 1). As such, a central bank would likely observe the practice of other CBDCs to respond flexibly to developments in crucial areas like international payments (Bank of Japan, 2020, pp. 15–16). Central banks may have as an impetus for issuing CBDC a desire to avoid obsolescence by joining a CBDC cluster.

Policy diffusion is a mixed bag. Networks may promote information flow, and the competition of ideas may help to identify solutions. However, these processes are not without their challenges, including the possible manipulation of information flow and the impact power imbalances may have on learning. Conscious action is then necessary to overcome these challenges.

3.2. Cooperation and conflict

The CBDC network could bring both cooperation and conflict concerning CBDC regulation, with these factors themselves influenced by existing interdependencies among actors (Maoz, 2012, p. 250) and the network's dynamics (Hafner-Burton et al., 2009, p. 569).

3.2.1. Cooperation

Cooperation by, rather than competition between, actors in a network is critical to avoid undesirable outcomes (Elkins, 2009, p. 62). Undesirable outcomes include a race to the bottom and regulatory arbitrage. If there are

minimum standards at the regional level or above, these standards may help prevent or mitigate a race to the bottom (Hertig, 2000, p. 374). Cooperation may lead to regulatory coordination. Traditionally, central banks have effectively developed informal networks of cooperation such as the Basel Committee on Banking Supervision (Lastra, 2015, p. 32). Calls have been made for international cooperation including that on CBDC standard-setting (see, e.g., Reuters Staff, 2020). Taking standards regarding payment data as an example, "the ability to carry data about the payment in a standardised form which can be readily understood and reported is crucial" (SWIFT & Accenture, 2021, p. 7).

Cooperation would promote financial stability. Cooperation helps promote the safety, integrity, and stability of the CBDC system and broader international monetary system (G7, 2021, pp. 11, 24). It is predicted that one CBDC could affect other jurisdictions' "monetary policy or financial stability (eg through 'dollarization')" (Bank of Canada et al., 2020, p. 17). In the same vein, a flawed CBDC can impact other jurisdictions' financial stability, and a CBDC-related cyberattack in one nation could affect other economies and confidence in CBDC or certain technologies (Brainard, 2020, p. 4). Cooperation would help to improve the design of CBDC, produce a better understanding of its domestic and international distributive effects, and address issues that could trigger financial or security crises.

Cooperation would have other benefits, promoting efficiency, fluidity, and transparency while reducing transaction costs and complexity such as those arising from regulatory compliance (Bank for International Settlements, 2021). For instance, improved efficiency could be achieved through reduced "barriers to cross-border compatibility" (Committee on Payments and Market Infrastructures et al., 2022, p. 2), connections among CBDCs (minimizing frictions in cross-border payments by optimizing, inter alia, payment formats, currency convertibility, and data flow), and standardization of IT on CBDC to name a few. There will likely be pushes toward harmonized regulatory frameworks (International Monetary Fund Inter-Departmental Staff Team, 2020, p. 8). Moreover, cooperation could pool rather than duplicate resources (including technical resources and physical assets). It also helps promote compliance in areas like AML/CTF regulation (G7, 2021, p. 24), and competition and privacy issues (Committee on Payments and Market Infrastructures et al., 2022, p. 2).

However, the likely structure of the CBDC network as a decentralized network with predominant elements of a network-as-structure would make it difficult to facilitate network-wide, deep cooperation. Different regulatory philosophies, adjustment costs arising from new international standards, and the possible negative impact on one state's competitive positions in attracting financial transactions and capital could create roadblocks to cooperation (Brummer, 2015, pp. 134–139). To illustrate, different central bank laws on issuance powers and types of currency may increase the difficulties of cooperation. Shifting geopolitical dynamics (such as the Ukraine crisis) could also affect states' perspectives on cooperation. For example, some CBDC frameworks may enable responses to or the imposition of economic sanctions, where coordination between states would prove difficult. Essentially, CBDC considerations differ substantially between actors and can change over time on issues like transparency and stakeholder accountability (Kiff et al., 2020, pp. 42, 45).

Cooperation, particularly deep cooperation or regulatory coordination, would likely occur within clusters. Currently, deep collaboration appears to be limited to a number of central banks. For example, "the CBDC coalition of central banks" involves a small number of central banks such as the Federal Reserve (Brainard, 2020, p. 4), who, with the BIS, share their experiences in assessing the case for CBDC and to discuss cross-border interoperability (Bank of England, 2020). This group of central banks emphasizes practical policy development and technical experiments (Bank of Japan, 2020, p. 19). They are exploring a series of collaborations (such as on the common principles and key features of CBDCs) (Bank of Canada et al., 2020, p. 1), with a common motivation to avoid unwarranted barriers to cross-border electronic transfers of currencies (Yeung, 2020). The G7 has also developed public policy principles for retail CBDCs (G7, 2021).

There is a possibility that these different groups may come to constitute clusters within the network in the future. Nodes in similar structural positions vis-à-vis other nodes are expected to act in similar ways (Hafner-Burton et al., 2009, p. 567). However, whether these clusters will continue to cooperate remains to be seen.

As discussed above, the CBDC network is likely to develop in a decentralized way. To maximize the benefits of such a network, central banks should approach policy development carefully and with an eye to how network effects can facilitate this process. Policy stances may vary according to the context and be dependent on the specific actors and clusters. That said, cooperation could be strengthened in several ways.

First, policymakers should focus on addressing common challenges as seen in other regulatory networks (van der Heijden, 2021, p. 1). Shared problems include financial inclusion, the efficient and low-cost functioning of the payment system, and determining the central bank's role in the monetary system (Kiff et al., 2020, p. 5). Regulatory cooperation could help regulators deliberate about responses to shared problems, promote ad hoc interactions, and build consensus (Silvers, 2021, p. 1278), and this depends on the willingness and capacity of actors in utilizing cooperative mechanisms like MOUs (Bromberg et al., 2017, p. 77).

Second, cooperation requires the building of trust between actors as much as possible in areas of common interest (Rathbun, 2012, p. 323). To facilitate trust, negotiations should be conducted at not only the bilateral level, but at the regional and multilateral level through both formal organizations (e.g., the BIS) and "informal" groupings (e.g., G20, G7; see Lastra, 2015, pp. 543–544). While such engagement could involve third-party supervision, supervision may promote or deteriorate trust, depending on the actors' political willingness and their interactions (Wirth, 2009, p. 491). For instance, discussions convened by the IMF, if successful, can influence policy and reduce misunderstandings (Carney, 2019, p. 12). These discussions may lead to the development of hard law and soft guidelines and principles to aid the effective development of CBDC systems.

Third and more specifically, as observed in other networks, credible signaling could help build trust, which includes credible information sharing and communication between actors, and small actions costly enough to signal genuine, rather than exploitative, intent (Kinne, 2013a, pp. 663, 673). A network containing sufficient trust between actors could be "a repository of information on the availability, competencies, and reliability of prospective partners" with the node's positions "signal[ling] their willingness, experience, and ability to enter partnerships [with] others," which helps to reduce uncertainty in actors' decisionmaking in selecting partners for collaboration (van der Heijden 2021, p. 4).

In any event, the CBDC network is likely to present a complex scenario given the divergent political, economic, and technical factors among actors. No consistent, widely accepted position exists on CBDC issues such as data regulation and privacy protection (Bossu et al., 2020, p. 4). While the harmonization of rules may be advantageous, at least from the standpoint of cross-border use of CBDC, it may take some time before this is possible.

3.2.2. Conflict

Conflict understood in its broad sense, including incompatibility of different technical standards, is likely to arise in the CBDC network. The uncoordinated network-as-structure from this network is likely to take means different CBDC paradigms will emerge, which may give rise to conflict. Learning, as discussed above, has significant weaknesses and cannot be expected to bring convergence, particularly given such vast differences among states.

While there are many reasons for different CBDC paradigms adopted by states, key among them is the different capacities (a largely "objective" factor) and motivations of states regarding CBDC (a largely "subjective" factor). CBDC is essentially a national project that reflects national capacity and preferences. Divergent preferences may make deep cooperation difficult (Bromberg et al., 2017, p. 78) and even give rise to conflict.

The technical and regulatory complexity of CBDC requires central banks to have sufficient capacity to meet these issues. CBDC involves complex traditional issues (particularly monetary sovereignty) and new issues (e.g., cyber security, data, and a likely CBDC-related digital identity system) (Bank of Canada et al., 2020, p. 7). Regulators are likely to encounter challenges in resources, experience, and expertise to address numerous technical and regulatory issues. Technical issues include the scale of CBDC adoption, the use of DLT and smart contracts, algorithms, cyber security protections, rectifying erroneous payments, and data quality (Didenko et al., 2020, p. 36). They require the capacity of central banks to staff and operate cyber-security and the CBDC life cycle support for a 24/7/365 CBDC system (Kiff et al., 2020, p. 20). Legal issues include constitutional issues, such as whether rules related to currency allow the issue of CBDC (Bossu et al., 2020, p. 28), and laws concerning central bank powers, currency issuance, and payment systems (Bossu et al., 2020, pp. 16–26). States will equally need to consider monetary law issues such as whether CBDC may be considered a new official means of payment, and whether the technical requirements raise "fundamental fairness and public policy concerns" creating unequal access to CBDC use (Bossu et al., 2020, pp. 29, 35, 39–40), as well as private law issues like whether CBDC would be subject to property law (Group of Thirty, 2020, p. 18).

Motivations regarding CBDC are affected by a country's socio-economic, technological, and even geo-economic situation. To illustrate, the possible digital dollar would have "very different design features" from those of China's CBDC, indicating their "very different domestic and global monetary, financial, economic and political contexts" (Zetzsche et al., 2020, pp. 11–12). Notably, motivations of CBDC often include but are not limited to: (i) payment (e.g., access to central bank money, fiscal transfers, resilience, financial inclusion, international payments); (ii) monetary policy; and (iii) financial stability (e.g., possible disintermediation of banks and monetary sovereignty) (Bank of Canada et al., 2020, pp. 5–9). Different states would have different motivations. Taking payment as an example, some states may use CBDCs to "curb the growth of private payment providers and cryptocurrencies, which they see as a competitive risk to central bank-issued cash" (Raghuveera & Bray, 2020). Others may be more interested in the role of CBDCs in advancing digital payments systems (Raghuveera & Bray, 2020). Motivations are also intertwined with central bank objectives served by CBDC (e.g., payment system stability, financial stability, consumer protection, and economic development) (Kiff et al., 2020, p. 42). In practice, states may accordingly highlight different facets of CBDC, such as monetary sovereignty, exchange rate regimes and the regulation of currency exchange (Zhou, 2020), international trade payments, settlement and payment in the financial market, or cross-border remittances (Boao Forum for Asia, 2020).

Grounded in their own capacity and motivations, states will likely impose divergent CBDC regulation. This may lead to regulatory competition and lower or higher regulatory standards. Such a situation may cause conflict. Incongruence in regulation can develop from differing regulatory objectives, tools, and thresholds (e.g., minimum standards regarding privacy protection). States highlighting competition in the private sector may prefer more decentralization in CBDC design and regulation, while states highlighting CBDC's role to address the possible breakdown of other systems may prefer more centralization. This would affect, inter alia, the regulation of emerging players in the CBDC ecosystem (SWIFT & Accenture, 2021, p. 17). Relatedly, intermediaries between CBDC systems may be formalized with only one or two nominated institutions or be more open to competition (SWIFT & Accenture, 2021, p. 8).

Essentially, different motivations and capacities would mean different tradeoffs regarding CBDC domestically, as opposed to other countries, and within a cluster, as opposed to different clusters. These involve the balance between financial integrity (e.g., limiting the size of anonymous CBDC transactions and holdings) and privacy (e.g., a certain level of anonymity to promote usability) (Kiff et al., 2020, pp. 29–30), financial integrity and digital developments (Kiff et al., 2020, p. 28), and efficiency and security (Bank of Canada et al., 2020, p. 15). As a prime example, divergent considerations exist regarding data. Some countries are likely to prioritize privacy of end-user information, while other countries may prioritize efficiency and the utility of data. As seen in other regulatory networks, different regulators have varying standards regarding the management of sensitive information (van der Heijden 2021, p. 1). Differing tradeoffs would also affect legal restrictions, including different requirements to open digital wallets, different approaches regarding whether and under what specific circumstances a third party may freeze assets (Binance Research (Jinze & Etienne), 2019), and differing central bank cyber resilience (Kiff et al., 2020, pp. 14, 17). CBDC challenges the "fundamental relationship between money, the State, and the law" (Bossu et al., 2020, p. 5), on which different states have different views.

Divergence is likely to cause conflict, particularly regarding cross-border operability. Cross-border payments would face major challenges of interoperability and divergent regulatory frameworks (Bank of Canada et al., 2020, p. 7). Interoperability is the connection between national CBDC systems, ideally with common standards that would enable the participation of private actors (e.g., payment providers) (Auer, Haene, & Holden, 2021, p. 3). However, central banks that have launched pilot CBDC programs, and those that have investigated launching a CBDC have proposed materially different specifications (Bank of Israel, 2018, p. 8). States "tend to underinvest" in cross-border public goods and interoperability (Zhang, 2021). It is yet to be seen if and how central banks would agree on intermediary arrangements, under which institutions may act as partners, be present in both systems or have another institution carry out the function (SWIFT & Accenture, 2021, p. 8). As discussed above, data transmission is a contested issue and may generate complexity and uncertainty in the usage of CBDCs across borders (SWIFT and Accenture, 2021, pp. 8, 16). While bilateral solutions between two states may work between them, they are "not scalable and quickly becomes unmanageable if applied globally" (SWIFT & Accenture, 2021, p. 8). More broadly, central banks face potential conflicts between different objectives (Kiff et al., 2020, p. 42). It remains to be seen whether a stable relationship among CBDC actors would be maintained.

Relatedly, strategic reasons and mixed incentives may exist in a network and lead to greater incompatibility in the form of a lack of adoption of homogeneous standards (Cowhey & Mueller, 2009, pp. 179–180). There is even the possibility that actors may manipulate the network structure for their own gain (Lake & Wong, 2009, p. 131). Such manipulation would include the manipulation of information flow (e.g., only sharing select information or delaying disclosure), and the possible misuse of exchanged information for purposes other than those intended (van der Heijden 2021, pp. 2, 4).

Conflict would negatively affect network efficiency and the network's capacity to withstand possible disruption from threats like cyber-attacks. Potential issues range from the avoidance of rules and regulatory arbitrage to increased compliance costs. To illustrate, particular CBDCs may be adopted to circumvent controls in other jurisdictions (Bank of Canada et al., 2020, p. 17).

3.3. Summary

Regulatory coordination at an international level is needed for the regulation to be effective and prevent regulatory arbitrage (Beau, 2021, p. 3). It can be anticipated that the CBDC network will bring policy diffusion effects by promoting learning from and the adaptation of other states' policies. But these processes may not necessarily lead to coordination or convergence in regulation. Various orientations of state nodes could result in regulation different from the desirable regulation at an international level (Godwin et al., 2017, p. 42). This possible divergence is because of the decentralized, network-as-structure shape the potential CBDC network is likely to take. States would likely behave instrumentally due to factors like currency competition, which may create conflict that results in greater fragmentation in international financial system.

4. The impact of the CBDC network on the GFN: From a centralized GFN to a flat one?

Due to its different structure and form, the CBDC network is likely to profoundly affect the GFN. Generally, the CBDC network will likely be a crucial subnetwork of the GFN, given CBDC's far-reaching implications for the international financial system concerning payments, capital flows, reserves, and foreign exchange. CBDCs could also bring substantial changes in retail (e.g., instantaneous settlement and real time person-to-person [online and offline] transfers), wholesale, and cross-border payments (e.g., 24/7 operation, and direct exchange of currencies with less need for intermediary currencies) (SWIFT and Accenture, 2021, pp. 8, 11). A CBDC may even become an international reserve currency that challenges the dollar's dominance (Carstens, 2021).

Specifically, the CBDC network would add an additional and complex layer on top of the existing ties between various actors in the GFN. The changes brought by CBDC on payment systems would affect the GFN, given its "complicated network of exposures" (Lastra, 2015, p. 187). While we expect CBDC to build on existing links, it may offer a fresh start for a new cross-currency transactions infrastructure, given the need for new cross-currency transactions infrastructure (Peterson Institute for International Economics, 2021).

4.1. Major effect of the CBDC network on the GFN

CBDC is likely to affect the power imbalances in the GFN. Essentially, the structure of the CBDC network will determine its effect on the GFN. If the CBDC network's structure is similar to the GFN, it would likely strengthen the GFN's structure. Otherwise, the CBDC network may change the GFN's structure. The key is whether the positions of actors are to be strengthened or weakened by CBDC.

The GFN is currently a centralized system, with the US currency system as the core and the US dollar operating as the primary currency of main markets, while emerging economies are currently not among the top nodes (Sarpong & Deodutt, 2019, p. 4). Notably, network effects have entrenched the dollar and hierarchies of "regulatory influence and power" in the international financial system (Brummer, 2015, pp. 63, 117).

The centralized structure of the GFN is subject to change. Alongside deep changes following the global financial crisis, the GFN's structure is incrementally developing from a centralized one to a decentralized one with the rapid economic growth of BRICs and the Eurozone's increasing institutional importance incrementally affecting American centrality (Oatley et al., 2013, pp. 134, 146; Sarpong & Deodutt, 2019, p. 10).

The decentralized structure of the potential CBDC network, along with technical advancements, may further decentralize the GFN. CBDCs, along with private digital currencies, could create competing currency blocks (Didenko et al., 2020, p. 5). CBDCs will likely enable states to "operate outside the US dollar-led system by serving as a means to create independent payment mechanisms," allowing the export of "payment system values independent from the current global system" (Raghuveera & Bray, 2020). For instance, Daryl Guppy argued that an RMB-based CBDC will provide "a functional alternative to the dollar settlement system" and further develop "an RMB-based trade settlement system as an alternative to dollar settlement" (Guppy, 2020). However, China's RMB is not a fully convertible currency and China has a limited presence in international monetary system (Oatley et al., 2013, pp. 147, 149, footnote 27). The operation and future role of China's CBDC remain to be seen.

Crucially, technological advancements could disrupt the network externalities that maintain the "incumbent global reserve currency" system (Carney, 2019, pp. 14, 15). In the past experience of the GFN, positive network effects can push foreign markets and regulators "towards US norms" (Brummer, 2015, p. 58). However, digitalization through CBDC may enable cross-border transactions through new, alternative digital platforms (Zhang, 2021). Such platforms are likely to include CBDC infrastructure such as multi-CBDC platforms led by central banks. Reserve currencies may be repositioned by changes in demand, technological developments, the growth of alternative international payment "rails" and shifts to CBDC-denominated trade-invoicing and financial intermediation (Zhang, 2021). Differing from cash, CBDCs generate a huge amount of data that is crucial in the digital age and can be used in big data analysis. CBDCs, if used across borders, could enable access to data such as that regarding trade (Didenko et al., 2020, p. 39). CBDCs could also work with new payment systems that reduce exposure of payments data to the US-led financial system (Reuters Staff, 2021c). After the emergence of CBDCs, the GFN would likely not be the same "hierarchical network" as before (Oatley et al., 2013, p. 135).

4.2. Uncertainties

It is uncertain whether the GFN will eventually shift to a flat network even with the emergence of CBDC. If the digital dollar is introduced (Brett, 2020), this would slow down such a shift, as networks often reflect existing asymmetries of power (Faul, 2016, p. 185). Meanwhile, the digital dollar is observed to be a rare opportunity of reshaping the dollar (Guida, 2021). It is also unlikely that the dollar will lose its dominant position in the short term. In international financial systems, "regulators of larger, richer markets have more resources and are often better positioned to promote their agendas" (Brummer, 2015, p. 68). Obviously, "[t]ransitions between global reserve currencies are rare events given the strong complementarities between the international functions of money" (Carney, 2019, p. 13).

The GFN may become disordered and even return to a centralized network if the flat structure does not work. CBDC requires various preconditions, ranging from reasonable operation costs to regulation and resilient infrastructure (Kiff et al., 2020, p. 18). To illustrate, digitalization would not initially lead to cost reduction, given CBDC's substantial development and operational costs which may prove more economically feasible for larger nations (Kiff et al., 2020, pp. 12, 13). Many regulatory issues are far from clear, including how to ensure technological neutrality and ensure users can choose between payments means (Nabilou, 2019a, p. 11).

It is also unclear whether and how the CBDC network could address the tension between its decentralized structure and the need for strong governance regarding crucial issues like CBDC interchange mechanisms and digital identity frameworks (SWIFT & Accenture, 2021, pp. 8, 10). The governance challenges include technology standards, scalability, interoperability, privacy concerns, and potential risks in the CBDC issuance and operation (Nabilou, 2019b, p. 269). Different states with different levels of trust in CBDC systems are then likely to choose their own regulation of CBDC. As seen in previous experiences of financial regulation, optimal regimes can be undermined by arbitragers "target[ting] the weakest regime" (Brummer, 2015, p. 134). Solving these issues requires sufficient information-sharing and trust (Brummer, 2015, p. 134), which are the thorny issues faced by the CBDC network as discussed above.

The development of both a CBDC network and the GFN will be a dynamic process of finding a competitive equilibrium in international monetary systems and financial stability. The future remains unclear, and international cooperation will face serious challenges.

5. Concluding remarks

CBDCs are likely to form a network that could be a game challenger in the international financial system and will in all likelihood transform currency and related data. The incremental implementation of CBDC by different economies can be expected to lead to the development of a CBDC network or multiple CBDC networks, which will likely take shape as a decentralized network, and as a whole adopt the form of an uncoordinated network-as-structure rather than a network-as-actor.

The CBDC network would bring profound implications for regulation, bringing policy diffusion effects (learning and adaptation) but not necessarily lead to convergence. States in the CBDC network can be predicted to behave instrumentally in response to CBDC's disruptive effect, and the CBDC network would bring limited cooperation and generate greater conflict. The conflict is likely to bring fragmentation in the international monetary system.

Foremost, actors will need to address conflicts in the CBDC network to avoid lose-lose outcomes. International organizations will be important for promoting cooperation and could be a kind of international hub for CBDC cooperation given, among other factors, their legitimacy, pathway dependence, and ability to promote the flow of information (including best practices, knowledge sharing) and to consult with stakeholders (Elkins, 2009, p. 62). International organizations would help actors address certain barriers in cooperation "by acting as brokers themselves or by providing platforms or opportunities" for actors to meet (van der Heijden 2021, p. 13), and provide technical assistance. Such international collaboration through international organizations arguably reflects path dependence regarding some processes of the network development (Porter, 2014, p. 114).

Second, it is vital to avoid a race to the bottom that may result from regulatory competition (Provost, 2016, p. 540) in the CBDC network. Many nodes may compete to attract international users and enhance their roles in their cluster and the broader CBDC network. Users may prefer to use the CBDC with the least regulatory requirements. Therefore, it would be important for regulatory coordination to develop minimal regulatory standards and enhanced transparency in CBDC design, especially in crucial areas like data protection and payments. For instance, the BIS may play a crucial role in facilitating the coordination of regulatory standards. Given the difficulties in international coordination, the development of a code of conduct may be the first, albeit partial, step to address major problems (Stein, 2009, p. 152). Meanwhile, regulatory co-opetition (a combination of competition and cooperation) may promote optimal governance if everything goes smoothly (Esty & Geradin, 2000, p. 235).

Third, rules need to be developed with foresight to address potential issues. Legal changes need to be prepared well in advance, including how accommodative the rules will be to foreign CBDCs, and how to ensure coherence with exchange control mechanisms if any (International Monetary Fund Inter-Departmental Staff Team, 2020, p. 31). The regulation needs to evolve as CBDC technical design and practice develop. Legal issues should be managed to develop "shared working norms" as far as possible to minimize risks and ensure global financial stability (Raghuveera & Bray, 2020). Moving forward, international regime analysis may be useful when "formal norms, values or beliefs" have converged (Egelston et al., 2019, p. 3) and CBDC outcomes could be "influenced by a constellation of rules" (Martin & Simmons, 1998, p. 737).

The structure of the CBDC network could enable or constrain actors, while the actors will, in turn, affect the network. It is well understood that the composition of a network is fast-changing and involves various jurisdictions (Buocza et al., 2019, p. 193). As CBDCs and the CBDC network are a moving target, the network's evolution and effects deserve close attention.

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