

International Dimension of CBDC: A Network Analysis

Heng Wang and Simin Gao*

Abstract: Central bank digital currency (CBDC), with its dramatic differences from paper currency in terms of both currency and data, is likely to be a game changer in the international financial system. CBDC would lead to new payment infrastructures and arrangements, and a CBDC network. However, the crucial international dimension of new payment infrastructures and arrangements is under-researched. This article examines what kind of CBDC network is likely to emerge in the future, and the impact it would have on regulation and the global financial network (GFN). It argues first that the CBDC network is likely to be a decentralized network and overall adopt an uncoordinated network-as-structure approach. Second, the CBDC network could bring policy diffusion effects but may not necessarily lead to convergence in regulation, as states would behave largely instrumentally. Third, a CBDC network would affect the GFN and particularly the power balance between different actors, possibly leading to a flatter network.

Key Words: central bank digital currency, global financial network, networks structure, policy diffusion, international financial system, international monetary system

I.	INTRODUCTION	2
II.	The CBDC NETWORK.....	5
A.	What is CBDC?	5
1.	The definition of CBDC	5
2.	Typology of CBDC	6
3.	Different technical designs of CBDC.....	7
B.	The Nodes, Ties, and Structure of the CBDC Network	8
1.	Nodes.....	9

* Heng Wang, Professor, School of Private and Commercial Law, and Co-Director of Herbert Smith Freehills CIBEL (China International Business and Economic Law) Centre, Faculty of Law and Justice, the University of New South Wales. Email: heng.wang1@unsw.edu.au.

Simin Gao, Associate Professor and Associate Dean, School of Law, Tsinghua University, J.S.D. University of Pennsylvania. Email: sgao@mail.tsinghua.edu.cn.

This paper has been awarded a best paper prize by Machine Lawyering’s 2021 Conference, “Human Sovereignty and Machine Efficiency in the Law,” sponsored by Faculty of Law, the Chinese University of Hong Kong, in January 2021. The authors are invited to be keynote speakers at this conference. An earlier version or part of this paper was presented at two workshops at Tsinghua University and UNSW, and DC FinTech Week. The authors are grateful to the insightful comments of and discussion with Ross P. Buckley, David Donald, Ronald Ker Wei Yu, and the participants of these events.

The authors are grateful to the UNSW-Tsinghua University Collaborative Research Fund “Financial Innovation and Regulatory Change in the Context of (De)globalisation” (RG180111) and UNSW Law’s Herbert Smith Freehills CIBEL Centre for the funding support, and to Melissa Vogt and Hamish Collings-Begg for their excellent research assistance and comments.

2. Ties	12
3. Network structure	14
C. The Form of CBDC Network: Networks-as-Actors v. Networks-as-Structures	18
III. THE NETWORK EFFECTS: THE IMPLICATIONS FOR CBDC REGULATION	19
A. Policy diffusion: Uncoordinated Interdependence	20
1. Learning	20
2. Adaptation	23
B. Cooperation and Conflict	24
1. Cooperation	24
2. Conflict	27
IV. THE IMPACT OF CBDC NETWORK ON THE GFN: FROM A CENTRALIZED GFN TO A FLAT ONE?	31
V. CONCLUDING REMARKS	34

I. INTRODUCTION

Central bank digital currency (CBDC) is the digital form of fiat currency. CBDC, such as China’s Digital Currency Electronic Payment (DCEP or DC/EP),¹ are gaining more and more attention. CBDC may be “the next milestone in the evolution of money”.² China is actively piloting its own CBDC, with “13 million transactions having been processed using the currency”,³ and is predicted to become the first major economy to issue CBDC.⁴ A number of other countries, such as Sweden, are also carefully considering the possibility of issuing a CBDC.

CBDC would lead to new payment infrastructures and arrangements, and a CBDC network. CBDC will be used in international and cross-currency payments⁵ and reshape payment systems. Moreover, CBDC is likely to be connected with supplementary systems (including applications) and data services. However, the crucial international dimension of new payment infrastructures and arrangements is under-researched.

¹ Bryan Michael Galvan & Kelly Le, *China’s New DCEP Could Fast-Forward the Nation into a Cashless Society*(2020), available at <https://forkast.news/china-dcep-accelerate-nation-cashless-society-privacy-digital-currency/>.

² Wouter Bossu, et al., *Legal Aspects of Central Bank Digital Currency: Central Bank and Monetary Law Considerations*, IMF WORKING PAPER NO. 2020/254, 4 (2020).

³ Karen Yeung, *China Not Among Major Central Banks in Talks on Global Digital Currency Principles*, South China Morning Post(2020), available at https://www.scmp.com/economy/china-economy/article/3104905/china-not-among-major-central-banks-talks-global-digital?utm_medium=email&utm_source=mailchimp&utm_campaign=enlz-scmp_china&utm_content=20201009&tpcc=enlz-scmp_china&MCUID=b2992489b1&MCCampaignID=c2e928c32f&MCAccountID=3775521f5f542047246d9c827&tc=5.

⁴ *China Aims to Launch the World’s First Official Digital Currency*, The Economist(2020), available at <https://www.economist.com/finance-and-economics/2020/04/23/china-aims-to-launch-the-worlds-first-official-digital-currency>.

⁵ Bank of Canada, et al., *Central Bank Digital Currencies: Foundational Principles and Core Features*, 7 (2020).

The Facebook-led, private stablecoin Libra (now renamed Diem), China's CBDC, and COVID-19 have put CBDC "on top of the agenda of many central banks".⁶ As a major private global stablecoin, Libra challenges the role of central banks in the international monetary system. COVID-19 has led to concerns over the possible spread of the COVID-19 virus by cash, new government-to-person payment arrangements to combat COVID-19 issues, and more attention being given to "the value of access to diverse means of payments, and the need for any payment method to be both inclusive and resilient against a broad range of threats", resulting in an even greater focus on CBDC.⁷ The US Congress is also considering introducing a digital dollar in its COVID-19 response legislative package.⁸

CBDC is a gamechanger in the international financial and monetary system for many reasons: the possible currency competition and the impact CBDCs can be expected to have on the existing monetary order, CBDC as a new or stronger policy instrument compared with traditional fiat currency (e.g., the generation of data and the possible involvement of digital identity), and the complexities arising from data, technology and regulation related to CBDC (e.g., data, digital identity, privacy, and national security). CBDC is deemed to be the cornerstone of the digital economy and the key to "competition among powers".⁹ It is observed that once fiat currency becomes digital, current "borders of economic influence are no longer going to be contained by political borders any more".¹⁰ Moreover, CBDC will be reshape payment systems, and lead to new payment infrastructures and arrangements.

This article explores a potential CBDC network and international dimension of such new payment infrastructures and arrangements, particularly implications for the future of the international monetary system. Such international dimension has received little scholarly attention. Utilizing network analysis, it explores the following crucial questions: What is the nature of a potential CBDC network? What are the network effects? How will a CBDC network impact the international financial system?

In network analysis, "networks" refer to a set of relationships (ties or links) between any set or sets of actors (nodes).¹¹ Networks are "a particular mode of organization, distinguished

⁶ Jason Brett, *How Project Libra And COVID-19 Drove Digital Dollar Idea In Congress*(2020), available at <https://www.forbes.com/sites/jasonbrett/2020/04/24/how-project-libra-and-covid-19-drove-digital-dollar-idea-in-congress/#3e5134702c51>.

⁷ Raphael Auer, et al., *Rise of the Central Bank Digital Currencies: Drivers, Approaches and Technologies*, BIS WORKING PAPERS No 880, 3, 29 (2020).

⁸ Brett. 2020.

⁹ Qian Yao, *Technological Considerations of Central Bank Digital Currency*, Yicai(March 6, 2018), available at <https://www.yicai.com/news/5404436.html>.

¹⁰ Yeung. 2020.

¹¹ Emilie M. Hafner-Burton, et al., *Network Analysis for International Relations*, 63 INTERNATIONAL ORGANIZATION 559, 562

from markets or state hierarchies”.¹² This paper analyses two networks. One is the global financial network (GFN), and the other is the possible future CBDC network. The current GFN is structured as a centralized network with the US currency system as the core and the currency of main markets as the top nodes, using traditional payment systems, such as SWIFT and the Clearing House Interbank Payments System (CHIPS), as links for all other countries. CBDCs, meanwhile, are likely to lead to the development of a CBDC network that is part of the GFN. As discussed below, the CBDC network would affect the GFN in a substantial and unprecedented way.

The analysis in this paper focuses on the nodes (actors) in these networks at the international level; that is, economies issuing currencies (for the CBDC network, the economies that are to issue or may consider issuing CBDC). These nodes are typically central banks rather than commercial banks, because central banks generally play the leading role in respect of CBDCs at present. The paper does, however, note how other actors (e.g., commercial banks) may interact with central banks as part of the network.¹³ There are three major central banks that probably have the “most leverage in the intensifying CBDC race” and thus deserve significant attention: the Federal Reserve, the European Central Bank (ECB) and the People’s Bank of China.¹⁴

Network analysis helps to provide a clear picture of what is currently happening and enables predictions as to network creation and development, as well as the investigation of networks’ impacts on actors’ behaviors.¹⁵ Concerning finance, network analysis is useful in, inter alia, exploring network structures that affect actors’ behavior and network effects,¹⁶ which are crucial for financial stability (e.g., the vulnerabilities arising from network interdependencies which could turn a local crisis into an international one).¹⁷ Essentially, the innovative CBDC network study in this article provides a key framework for deeper exploration of possible trends in the international monetary system particularly through the analysis of the effects of CBDCs. Due to the early stage of CBDC development and the lack

(2009); Thomas Oatley, et al., *The Political Economy of Global Finance: A Network Model*, 11 PERSPECTIVES ON POLITICS 133, 136 (2013).

¹² Hafner-Burton, et al., INTERNATIONAL ORGANIZATION, 559 (2009).

¹³ Sebastian Poledna, et al., *The Multi-Layer Network Nature of Systemic Risk and Its Implications for the Costs of Financial Crises*, 20 JOURNAL OF FINANCIAL STABILITY 70, 71 (2015).

¹⁴ Stephen O’Neal, *Global Compatibility Is a Key Factor in the CBDC Race, Says Expert*(2020), available at <https://coingeography.com/news/global-compatibility-is-a-key-factor-in-the-cbdc-race-says-expert>.

¹⁵ Hafner-Burton, et al., INTERNATIONAL ORGANIZATION, 563 (2009).

¹⁶ Peter Cowhey & Milton Mueller, *Delegation, Networks, and Internet Governance*, in NETWORKED POLITICS: AGENCY, POWER, AND GOVERNANCE 177, 180, (Miles Kahler ed. 2009).

¹⁷ Franklin Allen & Ana Babus, *Networks in Finance*, WHARTON FINANCIAL INSTITUTIONS CENTER WORKING PAPER No. 08-07 1, 2.

of data, the paper provides predictions as to the CBDC network and proposes hypotheses to be tested based on the development of CBDC practice.

The paper proceeds as follows. Part II explores the approach a potential CBDC network may take, including the nodes, ties, and network structure. It further examines whether the CBDC network will take the approach of networks-as-actors or networks-as-structures. Part III explores the effects of the potential CBDC network from two dimensions: (i) policy diffusion (uncoordinated interdependence as reflected in learning and adaptation), and (ii) cooperation and conflict, including the reasons behind possible conflict. These effects carry profound implications for regulation. Part IV explores more broadly the impact of CBDC on the GFN, and whether the GFN is likely to shift from a centralized network to a flat one after the rise of the CBDC. Part V concludes with observations on the future of the international financial system. It should be noted that this paper does not aim to analyse the merits of CBDCs, which deserve separate careful analysis based on the particular design adopted.

II. The CBDC NETWORK

This part focuses on the emergence and development of a CBDC network among states. Based on the analysis of CBDC, it explores the potential nodes, ties and structure of a CBDC network, and then explores the approach of a CBDC network as networks-as-actors or networks-as-structures. In so doing, it uses network analysis, or the investigation of network structures,¹⁸ to “theorize about the dynamics of system and structural change.”¹⁹

A. *What is CBDC?*

At the beginning, it will be useful to explore the meaning of CBDC. Moreover, states are exploring or researching into different CBDC proposals, which involve various technological designs.

1. *The definition of CBDC*

As a first step, it is important to understand the definition of CBDC and how this lays a foundation for network analysis of CBDC. There are different definitions of CBDC and a widely accepted definition of CBDC is lacking. Basically, CBDC is “a central bank liability, denominated in an existing unit of account, which serves both as a medium of exchange and a store of value”.²⁰ Digital form and the central bank liability are key features of CBDC. Adopting a digital form, CBDC differs from traditional paper currency issued by central

¹⁸ Hafner-Burton, et al., INTERNATIONAL ORGANIZATION, 559 (2009).

¹⁹ Oatley, et al., PERSPECTIVES ON POLITICS, 137, 148 (2013).

²⁰ Bank for International Settlements, *Central Bank Digital Currencies*, 3 (2018).

banks. As a liability of a central bank and legal tender, CBDC differs from private money (e.g., credit balances on accounts in commercial banks as the liabilities of commercial banks) and cryptocurrencies (e.g., Bitcoins).²¹ Different central banks and researchers have proposed a range of systems for a CBDC, reflected in the numerous variations regarding CBDC proposals (as discussed below).

2. *Typology of CBDC*

There are different categories of CBDC proposals, including (i) account-based and value-based CBDC, and (ii) retail, wholesale, or “general purpose” CBDC. There are interest-bearing and non-interest bearing CBDCs. Other categories include 1-tier (direct) and 2-tier (indirect or synthetic) CBDCs.

An account-based CBDC is “booked in the accounts of the third parties holding accounts with the issuing central bank and the process of its transfer (including, in particular, the legal finality) would be conducted on the books of the issuing central bank”, while a value-based CBDC exists through digitally stored tokens stored in holders’ e-wallets, is transferred through a decentralized or peer-to-peer method, and may offer user anonymity concerning the central bank.²² CBDC could be issued in the form of files or “tokens” that could be stored in digital wallets provided by financial institutions and other entities.²³ Such CBDC would involve “digital tokens” being transferred directly from payer to payee, and verified by third parties.

A retail CBDC is designed for the general public (including individuals) without offering it to wholesale clients of central banks.²⁴ For instance, CBDC can take various forms, including “a digital form of central bank money denominated in the official unit of account for general purpose users.”²⁵ A CBDC could be based on a bank account issued by a central bank to each citizen as an exchange settlement account for day-to-day use (e.g., for deposits and electronic payments).²⁶ Wholesale CBDC is used by financial institutions who hold reserve deposits with a central bank,²⁷ while general purpose CBDC is available to retail and wholesale counterparties, including individuals and firms.²⁸ Wholesale CBDC are only issued

²¹ Bossu, et al., IMF WORKING PAPER NO. 2020/254, 7 (2020).

²² Hossein Nabilou & André Prüm, *Central Banks and Regulation of Cryptocurrencies*, UNIVERSITY OF LUXEMBOURG LAW WORKING PAPER NO. 2019-014 1, 39-40 (2019).

²³ Philip Lowe, *An eAUD?*, 7 (2017).

²⁴ Bossu, et al., IMF WORKING PAPER NO. 2020/254, 9 (2020); Tony Richards, et al., *Retail Central Bank Digital Currency: Design Considerations, Rationales and Implications*, THE BULLETIN, 31-47 (2020).

²⁵ Norges Bank, *Central Bank Digital Currencies*, NORGES BANK PAPERS, 5 (2018).

²⁶ Lowe, 9 (2017).

²⁷ Sayuri Shirai, *Money and Central Bank Digital Currency*, ADBI WORKING PAPER SERIES NO. 922, 14 (2019).

²⁸ Bossu, et al., IMF WORKING PAPER NO. 2020/254, 9 (2020); Bank of Japan, *The Bank of Japan's Approach to Central Bank Digital Currency*(2020), available at https://www.boj.or.jp/en/announcements/release_2020/data/rel201009e1.pdf.

to central banks' existing account holders and participants in their real-time gross settlement (RTGS) systems, who are often big "clearing" banks and public bodies.²⁹

Other additional categories include interest-bearing and non-interest bearing CBDCs.³⁰ There are also 1-tier (direct) and 2-tier (indirect or synthetic) CBDCs. Under a 1-tier CBDC, central banks directly issue the CBDC and administer its circulation; for the CBDC issuance in the 2-tier form, "the liability is issued by a commercial bank but is fully backed with central bank liabilities".³¹ Such hybrid form means direct claims on the central bank and payments handled by intermediaries.³² Many states are considering patterns in which a CBDC "is a direct claim on the central bank, but with private intermediaries".³³ CBDC can also be divided into centralized and decentralized CBDC: CBDC transfers can be settled in a centralized manner (as is the case with their current RTGS), or in a decentralized way (particularly by way of distributed ledger technology (DLT)).³⁴ Moreover, different states are also likely to have different views on whether and when CBDCs shall bear interest.³⁵

Different categories of CBDC are being explored by states. For instance, it is observed that "[r]etail CBDCs are more likely where there is a larger informal economy, and wholesale CBDCs are more advanced in economies that have higher financial development".³⁶ Research on CBDC by many economies is concerned with whole CBDC, while China's CBDC is a retail one.³⁷ Moreover, the Bank of Japan has stated that it will explore general purpose CBDC "in a more concrete and practical way by conducting experiments, rather than confining itself to conceptual research as before", and "consider the need for a pilot program if necessary", which could involve payment service providers and end users.³⁸

3. Different technical designs of CBDC

There are different technical designs of CBDC. Here the question of whether or not to use of DLT provides a good example. It is observed that "[m]any central banks are considering the issuance of token-based CBDC on DLT."³⁹ There are CBDC proposals regarding retail

²⁹ Bossu, et al., IMF WORKING PAPER NO. 2020/254, 9 (2020).

³⁰ Hossein Nabilou, *Central Bank Digital Currencies: Preliminary Legal Observations*, JOURNAL OF BANKING REGULATION, 25 (2019).

³¹ Bossu, et al., IMF WORKING PAPER NO. 2020/254, 10 (2020).

³² Id. at.

³³ Auer, et al., BIS WORKING PAPERS NO 880, 1, 28 (2020).

³⁴ Bossu, et al., IMF WORKING PAPER NO. 2020/254, 10 (2020).

³⁵ Nikhil Raghuvveera & David Bray, *Design Choices of Central Bank Digital Currencies Will Transform Digital Payments and Geopolitics*, Atlantic Council(2020), available at <https://www.atlanticcouncil.org/blogs/geotech-cues/design-choices-of-central-bank-digital-currencies-will-transform-digital-payments-and-geopolitics/>.

³⁶ Auer, et al., BIS WORKING PAPERS NO 880, 4 (2020).

³⁷ Ping Xie, *Ping Xie: After CBDC Infrastructure Is Developed, It Could Break Third-Party Payment Monopoly*(2020), available at <https://mp.weixin.qq.com/s/uHQs0mIPEZQIe8R5xz6vfA>.

³⁸ Bank of Japan, 17. 2020.

³⁹ Bossu, et al., IMF WORKING PAPER NO. 2020/254, 12 (2020).

and wholesale CBDCs based on DLT: (i) an account-based retail CBDC without DLT; (ii) a value-based retail CBDC without DLT, (iii) a retail CBDC based on DLT, and (iv) a wholesale CBDC based on DLT.⁴⁰ On the one hand, many central banks are examining the possibility of using DLT in payment systems.⁴¹ The Reserve Bank of Australia is working with commercial banks and a blockchain technology company to explore the possible use and ramifications of a wholesale CBDC using DLT.⁴² Singapore has initiated a project to examine the feasibility of a DLT-based CBDC, which focuses on the specification of blockchain-based infrastructure in the banking system.⁴³ Korea is also trialling blockchain for CBDC.⁴⁴ On the other hand, China’s CBDC reportedly “will not use blockchain, distributed ledger technology which allows transactions to be validated without the need for banks.”⁴⁵

To sum up, the complex technical and legal issues of CBDC not only reflect the traditional aspects of currency but also the need to address new issues like data generated by CBDC. These issues are not applicable or more complex than those that arise in respect of traditional paper currency. Certain states, including China, have been developing a legal basis in preparation for adopting CBDC.⁴⁶ The legal and regulatory frameworks of CBDCs concern many areas, ranging from banking and privacy (and user identification) to tax and competition.

B. The Nodes, Ties, and Structure of the CBDC Network

A CBDC network is likely to emerge in the near future, with the nodes being the economies that issue CBDC. The CBDC network can be expected to arise from the practices of multiple states developing and issuing CBDCs and the interactions among states this will necessitate. Overall, central banks have recently become more active in exploring possible CBDC implementation due to the challenge Libra represents to central banks’ role in the monetary system, the possible competition among fiat currencies, and the need to respond to emerging dynamics (e.g., reduced cash use, and electronic payment to help fight the COVID-19 outbreak), among other factors. A 2019 survey of the Bank for International Settlements

⁴⁰ Shirai, ADBI WORKING PAPER SERIES NO. 922, 14 (2019).

⁴¹ The Bank of Israel, *Report of the Team to Examine the Issue of Central Bank Digital Currency (CBDC)*, 2 (2018).

⁴² The Reserve Bank of Australia, *Reserve Bank Partners With Commonwealth Bank, National Australia Bank, Perpetual and Consensus Software on Wholesale Central Bank Digital Currency Research Project*(2020), available at <https://www.rba.gov.au/media-releases/2020/mr-20-27.html>.

⁴³ The Bank of Israel, 13 (2018).

⁴⁴ Ledger Insights, *Korea to Trial Blockchain for Its Central Bank Digital Currency*(2020), available at <https://www.ledgerinsights.com/korea-digital-won-blockchain-central-bank-digital-currency-cbdc/>.

⁴⁵ Alun John, *Explainer: How Does China’s Digital Yuan Work?*(2020), available at <https://www.reuters.com/article/us-china-currency-digital-explainer-idUSKBN27411T>.

⁴⁶ Bossu, et al., IMF WORKING PAPER NO. 2020/254, 9 (2020).

(BIS) reported an increased likelihood of a CBDC being issued, compared with 2018: “10% of central banks say they are likely to issue a general purpose CBDC in the short term (twice as many as last year)”;⁴⁷ and “the share of central banks (by number) that are likely to issue a retail CBDC over the medium term (in one to six years) doubled in 2019, to 20%”.⁴⁸ Moreover, “a full 80% of surveyed central banks are engaging in research, experimentation or development of CBDCs”.⁴⁹

Three perspectives are crucial for network theory: “(1) the number of nodes; (2) the density of the network or the frequency of interactions between nodes; and (3) the structure of the network, defined as the pattern of connections between nodes.”⁵⁰ Accordingly, this part will analyse the nodes, ties and structure of the CBDC network.

1. Nodes

For the number of nodes, the CBDC network would likely start at a small size based on the number of countries issuing CBDCs, and may develop depending on national attitudes towards CBDC. National attitudes towards CBDC can be broadly divided into three groups: supportive, mixed (wait and see), and against. Only a few states, such as Denmark and Ecuador,⁵¹ are explicitly against issuing CBDC. For instance, the central bank of Denmark has indicated that it is not planning to issue digital currency in the near future, since the payment system currently operating is efficient.⁵²

Most states take supportive or mixed attitudes towards CBDC. CBDCs have been introduced into several smaller economies (e.g., Bahamas⁵³, Lithuania⁵⁴), with the first CBDC being issued by Tunisia in 2010, in the form of an e-Dinar designed as a virtual account.⁵⁵ More recently, a number of countries are actively conducting pilot projects, with some seeming close to actual launch. China is considered to likely be the first major economy to issue a CBDC. As one of the first group of countries to research CBDC, China has been conducting research and developing experiments of CBDC since 2014.⁵⁶ Among developed

⁴⁷ Codruta Boar, et al., *Impending Arrival – A Sequel to the Survey on Central Bank Digital Currency*, BIS PAPERS NO 107, 7 (2020).

⁴⁸ Auer, et al., BIS WORKING PAPERS NO 880, 3 (2020).

⁴⁹ Id. at.

⁵⁰ David A. Lake & Wendy H. Wong, *The Politics of Network: Interests, Power and Human Rights Norms*, in NETWORKED POLITICS: AGENCY, POWER, AND GOVERNANCE 129, (Miles Kahler ed. 2009).

⁵¹ Stephen O'Neal, *State-Issued Digital Currencies: The Countries Which Adopted, Rejected or Researched the Concept*(2018), available at <https://cointelegraph.com/news/state-issued-digital-currencies-the-countries-which-adopted-rejected-or-researched-the-concept>.

⁵² The Bank of Israel, 2 (2018).

⁵³ Advait Palepu, *The Bahamas Issues World's First Central Bank Digital Currency*(2020), available at <https://www.medianama.com/2020/10/223-bahamas-issues-central-bank-digital-currency/>.

⁵⁴ Bossu, et al., IMF WORKING PAPER NO. 2020/254, 9 (2020).

⁵⁵ Eswar Prasad, *Central Banking in a Digital Age: Stock-Taking and Preliminary Thoughts*, 10 (April 2018).

⁵⁶ Qian Yao, *The Past and Present of Digital Currency*, 2018 CHINA LAW REVIEW, 175, 176 (2018).

states, Sweden started pilot testing its e-Krona in February 2020, and “probably is the closest developed economy to actual launch”.⁵⁷

A large number of economies have indicated that they intend to wait and see whether to adopt a CBDC. Various central banks, including the Bank of Canada and Bank of England, have indicated the need for multi-year research before a decision about adopting a CBDC is made.⁵⁸ The Bank of Canada and the Monetary Authority of Singapore have conducted pilots of CBDC, and the Bank of England has set a CBDC research agenda.⁵⁹ The Governing Council of ECB has also “decided to advance work on the possible issuance of a digital euro”,⁶⁰ and the ECB has launched a public consultation on a possible digital euro issuance in October 2020. The US Congress is considering whether to introduce a digital dollar in its COVID-19 response legislative package.⁶¹ Notably, a group of central banks of advanced economies, including Japan, the US and the UK,⁶² are “shifting their emphasis from conceptual research activities to practical policy analysis -- based on country-specific circumstances -- and technical experiments”.⁶³

The issuance of CBDC involves the balance of costs and benefits. It is observed that “most central banks appear to have clarified the challenges of launching a CBDC but they are not yet convinced that the benefits will outweigh the costs”.⁶⁴ Various concerns around CBDC affect countries’ positions on CBDC more generally, and the specific design to adopt, ranging from sovereignty and the limitations under technical and legal frameworks, to unsuccessful earlier attempts and the uncertain benefits of CBDC.⁶⁵ For instance, the ECB is working on CBDC but has said it will “only introduce a digital currency if we become firmly convinced that it is both necessary and proportionate to fulfil our tasks in ensuring the stability of our currency”.⁶⁶

On the one hand, CBDC has certain advantages regarding payment, including ensuring the public’s access to a central bank’s liability in the case of reduced cash use, streamlining

⁵⁷ Anton N. Didenko, et al., *After Libra, Digital Yuan and COVID-19: Central Bank Digital Currencies and the New World of Money and Payment Systems*, EUROPEAN BANKING INSTITUTE WORKING PAPER SERIES 65/2020 1, 20, footnote 78 (2020).

⁵⁸ Nurjannah Ahmat & Sabrina Bashir, *Central Bank Digital Currency: A Monetary Policy Perspective*, BANK NEGARA MALAYSIA STAFF INSIGHTS 2017/11, 2 (2017)..

⁵⁹ Didenko, et al., EUROPEAN BANKING INSTITUTE WORKING PAPER SERIES 65/2020, 20 (2020).

⁶⁰ Report on a Digital Euro. (2020).

⁶¹ Brett. 2020.

⁶² These central banks are the Bank of Canada, the Bank of England, the Bank of Japan, the European Central Bank, the Sveriges Riksbank, the Swiss National Bank, and the Federal Reserve System. They are working with the BIS.

⁶³ Bank of Japan, 19. 2020.

⁶⁴ Christian Barontini & Henry Holden, *Proceeding With Caution – a Survey on Central Bank Digital Currency*, BIS PAPERS NO 101, 12 (2019).

⁶⁵ Didenko, et al., EUROPEAN BANKING INSTITUTE WORKING PAPER SERIES 65/2020, 20 (2020).

⁶⁶ Yves Mersch, *Yves Mersch: An ECB Digital Currency – a Flight of Fancy?*(2020), available at <https://www.bis.org/review/r200511a.pdf>.

payments systems, and increasing competition in payment systems.⁶⁷ CBDC would help to “maintain the public’s access to a central bank’s liability in the event that the use of cash declines significantly”.⁶⁸ In terms of monetary policy, CBDCs may improve or maintain the effectiveness of monetary policy.⁶⁹ If properly managed, CBDC could bring enhanced efficiency and inclusiveness in the monetary system and the economy,⁷⁰ ease the transmission of changes in the central bank interest rate to the economy, and even improve GDP given the increased supply of risk-free assets.⁷¹ When needed, CBDC may allow “negative interest rates for cash”.⁷²

On the other hand, possible disadvantages of CBDC include the cost to establish new digital infrastructure or to convert a pre-existing system,⁷³ the possible risks to privacy compared with cash, and risks related to cyber security. As another example, the Bank of England is looking specifically at CBDC’s potential to undermine financial stability as a result of lower bank liquidity.⁷⁴

Overall, the number of nodes in the CBDC network is likely to increase over time. Central banks representing a fifth of the global population have indicated that they are likely to issue the first CBDCs in the coming few years.⁷⁵ The CBDC network will attract new adherents if it creates network externalities (including benefits provided to network members) such as liquidity. For instance, if CBDC is increasingly used as the means of payment and investment, the CBDC network can be expected to develop. In fact, the common motivation of a number of developed countries for exploring a CBDC is its use as a means of payment.⁷⁶ CBDC could be used internationally and potentially “simplify cross border transactions.”⁷⁷ If an increasing number of states adopt CBDC, this may lead to network effects that mean there is an “incremental benefit gained by an existing user for each new user that joins the network”.⁷⁸

⁶⁷ The Bank of Israel, 35 (2018).

⁶⁸ *Id.* at, 2.

⁶⁹ Mohammad Davoodalhosseini, et al., *CBDC and Monetary Policy*, Bank of Canada(2020), available at <https://www.bankofcanada.ca/2020/02/staff-analytical-note-2020-4/>.

⁷⁰ Chen Jia, *China Promotes Global Digital Fiat Currency Standardization*(2018), available at http://english.www.gov.cn/state_council/ministries/2018/12/08/content_281476424565376.htm.

⁷¹ The Bank of Israel, 13 (2018).

⁷² John. 2020.

⁷³ The Bank of Israel, 35 (2018).

⁷⁴ *Id.* at, 13.

⁷⁵ Boar, et al., BIS PAPERS NO 107, 1 (2020).

⁷⁶ Bank of Canada, et al., 1 (2020).

⁷⁷ Miranda Wood, *How China’s Central Bank Digital Currency Will Help Renminbi to Challenge Dollar*(2019), available at <https://www.ledgerinsights.com/china-central-bank-digital-currency-cbdc-renminbi-dollar/>.

⁷⁸ Nicholas L. Johnson, *What are Network Effects?*, available at <https://www.applicoinc.com/blog/network-effects/>.

2. *Ties*

Regarding the density of the network or the frequency of interactions between nodes, this needs to be analysed on a case-by-case basis. The frequency of interactions between nodes is likely to be affected by their positions in the GFN and the roles associated with these positions. A node's location within existing networks influences the likelihood of tie formation, while the particular attributes of nodes may "make ties more or less likely to occur".⁷⁹

It can be predicted that the CBDC network would mainly have horizontal links (like those between central banks), although there would also be vertical links (e.g., the relationship between a central bank and domestic commercial banks in a jurisdiction), and "diagonal" links between a public actor of one state and private actors of another state⁸⁰ (for instance, a foreign bank involved in the international use of CBDC). Similar to the international financial system, the major actors in the CBDC network at the international level would be central banks, who are connected by economic and (geo)political links.⁸¹ The horizontal links or ties are the focus of this paper.

What are the forms of ties? Ties could take various forms such as interaction due to membership in international organizations or forums such as the Committee on Payments and Market Infrastructures at the BIS.⁸² In particular, the ties within the CBDC network are likely to be cross-border linkages in monetary and payments systems. In large part because CBDC could be used in international and cross-currency payments,⁸³ different actors will need to interact with each other in developing and issuing CBDCs, forming the basis for the network. More broadly, financial institutions are already connected through "networks of different types of financial contracts, such as credit, derivatives, foreign exchange, and securities",⁸⁴ with the development of CBDCs only serving to deepen these connections.

Some central banks are considering the international acceptance of CBDCs, which would further develop the CBDC network. This is the case with the assessment of CBDC possibility by the ECB, which considers global acceptance of CBDC in the long term.⁸⁵ So too does the Bank of Japan.⁸⁶ There are some suggestions that China's CBDC is likely to be

⁷⁹ Hafner-Burton, et al., INTERNATIONAL ORGANIZATION, 566-567 (2009).

⁸⁰ Oatley, et al., PERSPECTIVES ON POLITICS, 135 (2013).

⁸¹ Id. at.

⁸² Yeung. 2020.

⁸³ Bank of Canada, et al., 7 (2020).

⁸⁴ Poledna, et al., JOURNAL OF FINANCIAL STABILITY, 70 (2015).

⁸⁵ Raghuvveera & Bray. 2020.

⁸⁶ Bank of Japan, 3. 2020.

internationalized in the future,⁸⁷ in line with observations that the CBDC is linked to an effort to promote RMB internationalization.⁸⁸ China is likely to consider international digital RMB transactions as the next step, which is related to the payment system for trade and investments.⁸⁹ Moreover, the possibility of Chinese tourists using China's CBDC abroad is being explored by China and Singapore.⁹⁰

The ties could also be currency swap agreements, linkages in the foreign exchange systems, MOUs on fighting financial crimes (e.g., money laundering and the financing of terrorism), and information exchange agreements.

The ties are closely related to CBDC regulation. To illustrate, recipient states of a foreign CBDC could decide “the degree to which denomination and settlement of contracts in a foreign currency” will be lawfully authorized, and “the treatment of foreign CBDC in a recipient country could depend on the legal treatment of that CBDC in the issuing country (e.g., currency and legal tender status)”.⁹¹

What are the purposes of the ties? The ties between CBDC nodes would be channels for the transmission of materials (currency) and non-material products (e.g., information, and rules), and continuous models of association among nodes to develop structures that will in turn affect the nodes' behaviors.⁹² For instance, a major CBDC might be foreign exchange reserve of other countries. In other words, there are material and social ties among nodes,⁹³ depending on the context. To illustrate, the possible clusters in a network are patterns of relationships, and the relations are linked with “outcomes of interest”.⁹⁴ Nodes could form ties homophily due to common attributes, or heterophily to minimize weaknesses and share strengths.⁹⁵

What is the direction of the ties and its implications? The ties in the CBDC network can be expected to resemble ties in other networks, which are often binary. Binary ties include the recognition by each country of the other's CBDC, the possible swap of two CBDCs under currency swap arrangements and the compatibility and interoperability of two countries'

⁸⁷ See, e.g., Forkast.News, *China Hopes Its New Digital Currency Will Internationalize the RMB. When Might That Day Come?*(2020), available at <https://forkast.news/china-dcep-cbdc-digital-currency-rmb-yuan-zhiguo-he-podcast/>.

⁸⁸ Yeung. 2020.

⁸⁹ Id. at.

⁹⁰ Hu Yue & Denise Jia, *China's Didi Teams with Central Bank on Digital Currency Trial*(2020), available at <https://asia.nikkei.com/Spotlight/Caixin/China-s-Didi-teams-with-central-bank-on-digital-currency-trial>.

⁹¹ International Monetary Fund inter-departmental staff team, *Digital Money Across Borders: Macro-Financial Implications*, POLICY PAPER No.2020/050, 14 (2020).

⁹² Hafner-Burton, et al., INTERNATIONAL ORGANIZATION, 562 (2009).

⁹³ Id. at, 560.

⁹⁴ Id. at, 561.

⁹⁵ Id. at, 567-568.

CBDCs.⁹⁶ Similar with other networks, ties may be “symmetrical or asymmetrical (stronger in one direction than the other direction, as often occurs in international trade)”,⁹⁷ depending on the flow of currency. Relatedly, ties could be either positive or negative relations,⁹⁸ with the latter arising in contexts like economic sanctions. Importantly, the ties would affect the network structure, and could divide a network into subgroups (like clusters), as discussed below.⁹⁹ A node’s position in the network is based on its relationships with other nodes. Such position in the network represents a node’s power under the structural analysis of networks.¹⁰⁰

3. Network structure

In respect of the network structure, the CBDC network is likely to be a decentralized network. Network structure can be assessed by considering centrality. As indicated in Figure 1, there are two end points on a continuum in terms of centrality: a distributed network, and a centralized network. For a distributed network, the links between nodes are usually distributed, meaning most nodes have “the same number of links and nodes with many or few links are rare”.¹⁰¹ A distributed network could be a kind of lattice “with each node connected to its neighbors.”¹⁰² A distributed network (like the Internet) is less efficient but has the advantage of enhanced resilience to risks given the existence of multiple hubs (where ties could be “shut down, bypassed, and repaired” without harming the whole network in the case that a number of hubs fail to function).¹⁰³ A CBDC network can hardly be a distributed network as the CBDC nodes are not likely to have same number of links. This is because of different countries’ varying positions in the GFN (which is related to, inter alia, economic weight), and the performance of CBDCs. For instance, Venezuela’s Petro is not seen as successful,¹⁰⁴ and this affects its links with other states.

In a centralized network, one or more states will sit in a more central place than others.¹⁰⁵ A centralized network structure has a typical center-periphery attribute under which one actor

⁹⁶ For the analysis on currency swap arrangements and its implications, see, e.g., Deerga Raj Adhikari, *Has the Currency Swap Arrangement Affected the Value of Yuan?*, 8 INTERNATIONAL RESEARCH JOURNAL OF APPLIED FINANCE 12, 12-20 (2017).

⁹⁷ Hafner-Burton, et al., INTERNATIONAL ORGANIZATION, 563 (2009).

⁹⁸ Id. at.

⁹⁹ Id. at, 565.

¹⁰⁰ Id. at, 570.

¹⁰¹ Lake & Wong, 129. 2009.

¹⁰² Id. at.

¹⁰³ Andrew Sheng, *Financial Crisis and Global Governance: A Network Analysis*, COMMISSION ON GROWTH AND DEVELOPMENT WORKING PAPER No. 67, 4 (2010).

¹⁰⁴ Didenko, et al., EUROPEAN BANKING INSTITUTE WORKING PAPER SERIES 65/2020, 35 (2020).

¹⁰⁵ Prince Kwasi Sarpong & Jugith Deodutt, *Legal Theory of Finance: Evidence From Global Financial Networks*, 7 COGENT ECONOMICS & FINANCE, 1, 25 (2019).

is ensconced at the center and all other actors are on the periphery.¹⁰⁶ Given the sole hub, a centralized network has the advantage of being arguably the most efficient network structure, but is also most vulnerable if the hub fails.¹⁰⁷ The CBDC network is not likely to be a centralized network as it is not obvious which state would take such a central position in this context. The US is the “most influential” state “in terms of the size of its gross assets/liabilities and close links to other influential countries in the network”.¹⁰⁸ However, CBDCs other than the possible digital dollar, along with private digital currency (e.g., Libra), may gradually challenge the predominance of the US dollar. It is likely that CBDCs will enable states to “operate outside the US dollar-led system by serving as a means to create independent payment mechanisms that link financial institutions together without the need for correspondent banks and SWIFT”, including the establishment of their values for a monetary system, the export of “payment system values independent from the current global system”, financial transfers with less constraint, and transaction data collection (“digital exhaust”).¹⁰⁹ This would significantly enhance the capacity and power of some nodes, which would likely reduce dependence on the US dollar.

There are some suggestions that a CBDC will increase China’s potential to become a world financial power.¹¹⁰ 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”.¹¹¹ It is reported that China’s CBDC may help reduce reliance on the US dollar-based payment system.¹¹² Possibly working in this context like “dematerialized trade documents” (e.g., digital contracts), China’s CBDC has “the potential to displace other currencies in international transactions involving China, weakening the role of the US dollar in cross-border transactions involving China”.¹¹³ However, China’s RMB is not a fully convertible currency and China has limited presence in international banking.¹¹⁴ The operation of China’s CBDC (e.g., privacy protection) and the future role of the RMB remain to be seen.

¹⁰⁶ Oatley, et al., PERSPECTIVES ON POLITICS, 135-137 (2013).

¹⁰⁷ Sheng, COMMISSION ON GROWTH AND DEVELOPMENT WORKING PAPER NO. 67, 4 (2010).

¹⁰⁸ Yevgeniya Korniyenko, et al., *Evolution of the Global Financial Network and Contagion: A New Approach*, WORKING PAPER NO. 18/113, 12 (2018).

¹⁰⁹ Raghuvveera & Bray. 2020.

¹¹⁰ Oatley, et al., PERSPECTIVES ON POLITICS, 149, footnote 27 (2013).

¹¹¹ Daryl Guppy, *The Future of China's Economic Engagement*(2020), available at <https://www.chinadaily.com.cn/a/202004/24/WS5ea28240a310a8b2411516bf.html>.

¹¹² Yeung. 2020.

¹¹³ Didenko, et al., EUROPEAN BANKING INSTITUTE WORKING PAPER SERIES 65/2020, 39, 42 (2020).

¹¹⁴ Oatley, et al., PERSPECTIVES ON POLITICS, 147, 149, footnote 27 (2013).

In the middle of the network structure continuum sit decentralized networks, which consist of clusters. The CBDC network is likely to be a decentralized network. There is “no universal case for CBDC adoption yet”,¹¹⁵ and a coherent view is lacking across countries on how to approach CBDC. To illustrate, states have different regulatory approaches to data regulation and privacy protection. As another example, states with advanced digital payments and declining cash use may prioritize “the ongoing availability of a public sector-provided means of payment”, while states with a lower penetration of digital payments may be driven by financial inclusion.¹¹⁶

Clusters are likely to be formed by countries with similar interests or structural positions. To put it differently, clusters are groups of nodes. For a cluster, two nodes “belong to the same group if their direct ties to each other are dense enough (cohesive subgroups) or their ties to all other nodes are similar (structurally similar clusters)”.¹¹⁷ Such similarity may constitute the basis for forming clusters, and can involve many factors ranging from payment and monetary policy to even geo-economic considerations.¹¹⁸ These factors work together to influence a jurisdiction’s position on CBDC.

As in network practice,¹¹⁹ given the substantially differing considerations behind CBDC, small clusters of actors could emerge, with each cluster having their own, distinctive voice. Such voices may concern various aspects of CBDC, ranging from the value to design and standards of CBDC. For instance, it is argued that CBDCs may be used to “create new monetary systems that will be leveraged in great power competition to form economic alliances”.¹²⁰ This may occur through clusters, since actors within one cluster may act similarly. Under structural equivalence, a prominent relational mechanism in network analysis, it is predicted that “nodes in similar structural positions vis-à-vis other nodes will act in similar ways”, although similar behaviour does not necessarily mean cooperation and these nodes may also compete.¹²¹ In practice, imitating similar actors is “one of the simplest and most effective cognitive heuristics in the calculation of utilities”, and actors making

¹¹⁵ Bossu, et al., IMF WORKING PAPER No. 2020/254, 4 (2020).

¹¹⁶ Auer, et al., BIS WORKING PAPERS No 880, 28 (2020).

¹¹⁷ Hafner-Burton, et al., INTERNATIONAL ORGANIZATION, 565 (2009).

¹¹⁸ See, e.g., GeoEconomics Program and Belfer Center for Science and International Affairs, *The Rise of Central Bank Digital Currencies*(2020), available at <https://www.atlanticcouncil.org/blogs/econographics/the-rise-of-central-bank-digital-currencies/>;MAD, What is a CBDC or Central Bank Digital Currency? (2020).

¹¹⁹ Lake & Wong, *The Politics of Networks: Interests, Power and Human Rights Norms* 133, 135. 2009.

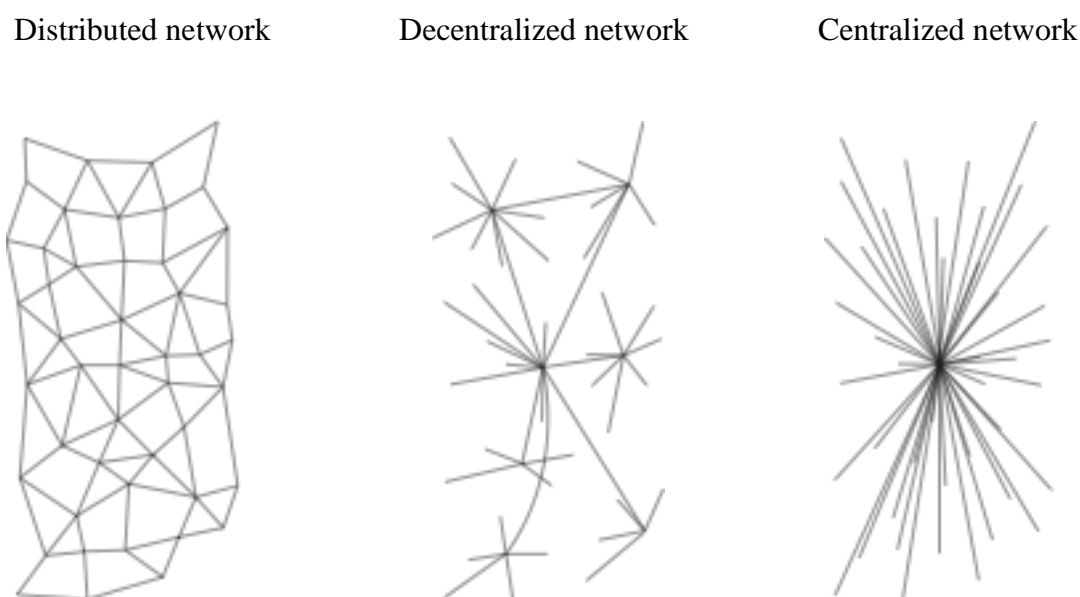
¹²⁰ Raghuvveera & Bray. 2020.

¹²¹ Hafner-Burton, et al., INTERNATIONAL ORGANIZATION, 567, 569 (2009).

complex choices often “regard the actions of actors with perceived common interests as a useful guide to their own behavior”.¹²²

That said, it is too early to tell how the clusters may be formed and how they are linked to each other. These clusters may not necessarily be linked via hubs as indicated in Figure 1. Such links will be affected by various factors including the capacity of digital infrastructure and technological innovation, government capacity, and legal arrangement.¹²³

Figure 1



Source: Adapted from Andrew Sheng, *Financial Crisis and Global Governance: A Network Analysis*, COMMISSION ON GROWTH AND DEVELOPMENT WORKING PAPER NO. 67.¹²⁴

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.¹²⁵ A flat network could consist of several parts in which certain actors are less connected with one part than others,¹²⁶ but actors are interconnected to more or less the similar extent.¹²⁷ Depending on the actual network, actors in a flat system could be thinly or densely connected.¹²⁸ The CBDC network would likely be closer to a relatively flat or multipolar network. This is because the central

¹²² Zachary Elkins, *Constitutional Networks*, in *NETWORKED POLITICS: AGENCY, POWER, AND GOVERNANCE* 55, (Miles Kahler ed. 2009).

¹²³ Auer, et al., *BIS WORKING PAPERS* No 880, 12 (2020).

¹²⁴ Sheng, *COMMISSION ON GROWTH AND DEVELOPMENT WORKING PAPER* No. 67, 4 (with slight adaptation of the original figure) (2010).

¹²⁵ Oatley, et al., *PERSPECTIVES ON POLITICS*, 135-137 (2013).

¹²⁶ Deborah Avant & Lindsay Heger, *The New Power Politics: Networks and Transnational Security Governance*, 4 (2013).

¹²⁷ Oatley, et al., *PERSPECTIVES ON POLITICS*, 147 (2013).

¹²⁸ Avant & Heger, 4 (2013).

node will likely be not as obvious as in other networks. Instead, there would likely be a multipolar structure as reflected in various clusters.

C. *The Form of CBDC Network: Networks-as-Actors v. Networks-as-Structures*

Based on the analysis of the nodes, ties and structure of the CBDC network, this part will further explore the approach of the CBDC network, and argue that the CBDC network would probably resemble a network-as-structure. Network theory can be classified into two, distinct approaches: networks-as-actors, where networks are seen as conscious, “thick intentional networks that are simultaneously both structures and agents” (such as advocacy network), and “purposeful, often strategic actor” with a design to “act collectively to further specific goals” (like Jubilee 2000 and Make Poverty History¹²⁹); and networks-as-structures, where networks are considered unintentional, “thinner, uncoordinated networks that only exist as structures”.¹³⁰ Networks-as-actors and networks-as-structures represent two ends of a continuum.¹³¹

For networks-as-actors, networks are “significant actors in international politics and represent a specific mode of international interaction and governance”.¹³² One may argue that the international monetary system shaped by the Bretton Woods conference was largely a network-as-actor. 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, and “most international transactions were denominated in dollars”.¹³³

Regarding networks-as-structures, the behaviour of actors in the network-as-structure is uncoordinated.¹³⁴ The relational structures and emergent attributes of the network shape the actions of its nodes.¹³⁵ Networks are a “set of relations that form structures” which in turn “constrain and enable” actors and influence the broad environment (e.g., agreements among states) and international outcomes (e.g., the possible conflict within the network).¹³⁶ Networks-as-structures affect the actors’ behavior in the networks, which will in turn bring network effects.¹³⁷ For networks-as-structures, the key is how actors respond “given both a

¹²⁹ Helen Yanacopoulos, *Cutting the Diamond: Networking Economic Justice*, in NETWORKED POLITICS: AGENCY, POWER, AND GOVERNANCE 71, (Miles Kahler ed. 2009).

¹³⁰ Kathryn Sikkink, *The Power of Networks in International Politics*, see id. at 229, 235, (Elkins, 47. 2009).

¹³¹ Sikkink, 229. 2009.

¹³² Hafner-Burton, et al., INTERNATIONAL ORGANIZATION, 561 (2009).

¹³³ Costigan Thomas, et al., *The US Dollar as the Global Reserve Currency: Implications for US Hegemony*, 8 WORLD REVIEW OF POLITICAL ECONOMY 104, 106 (2017).

¹³⁴ Elkins, 46. 2009.

¹³⁵ Miles Kahler, *Networked Politics: Agency, Power, and Governance*, see id. at 4, (

¹³⁶ Hafner-Burton, et al., INTERNATIONAL ORGANIZATION, 560, 561 (2009).

¹³⁷ Kahler, 4. 2009.

certain set of relationships (ties) with other actors and the characteristics of the network structure itself”, instead of the collective behavior of all actors.¹³⁸

Would a CBDC network be closer to a network-as-structure or network-as-actor? Most networks have elements of both networks-as-actors and networks-as-structures,¹³⁹ and so the CBDC network is likely to also have elements of both. The clusters in the CBDC network are likely to be close to networks-as-actors in the sense that different clusters may have their own voices and promote their own goals. Essentially, these elements of networks-as-actors are largely about the benefits and drawbacks of CBDC. The relative advantages and disadvantages of CBDC in the view of economies in a CBDC cluster vis-à-vis its competitors (e.g., Libra, bitcoins, and possibly even other CBDCs) are crucial. However, the whole CBDC network would not be like a network-as-actor, since all the actors would be unlikely to promote specific common goals given the substantial variety in their considerations and even values.

More broadly, the CBDC network as a whole would probably more closely resemble networks-as-structure, which may be suboptimal and fail to act collectively,¹⁴⁰ and are considered unintentional, “thinner, uncoordinated networks that only exist as structures”.¹⁴¹ There is a fundamental divergence in the CBDC considerations of different economies, and the design of a CBDC network is thus a particular challenge. The design of the CBDC network as a whole would in all likelihood not be intentionally undertaken by any actor(s), and so would not be set up to act collectively to achieve specific objectives. The CBDC network would thus lack the arrangement under the Bretton Woods system, but instead be a looser network without a strong central node, which would constrain its capacity to coordinate action.¹⁴² This contrasts with a network-as-actor for which “the very reason that they are linked is precisely so that they can act jointly”.¹⁴³ Essentially, the CBDC network would be affected by the practices of each jurisdiction which would likely differ greatly.

III. THE NETWORK EFFECTS: THE IMPLICATIONS FOR CBDC REGULATION

The shape of CBDC network likely to develop in the near future is a decentralized network that is overall a network-as-structure, although its clusters are closer to networks-as-actors. The following part explores the likely network effects, which concern the way nodes, clusters

¹³⁸ Elkins, 46. 2009.

¹³⁹ Sikkink, 228-229, 232, 245. 2009.

¹⁴⁰ *Id.* at, 235.

¹⁴¹ *Id.* at, 229, 235; Elkins, 47. 2009.

¹⁴² Lake & Wong, *The Politics of Networks: Interests, Power and Human Rights Norms* 149. 2009.

¹⁴³ Elkins, 46. 2009.

of nodes, and the network will affect “processes and outcomes of interest”.¹⁴⁴ In so doing, this part considers the implications of a CBDC network for financial regulation, particularly policy diffusion, conflict and cooperation in regulation.

A. Policy diffusion: Uncoordinated Interdependence

Arising out of the CBDC network’s overall approach as a network-as-structure, a CBDC network could bring policy diffusion but not necessarily convergence. Policy diffusion means that “policies in one unit (country, state, city, etc.) are influenced by the policies of other units”,¹⁴⁵ and refers to “a general set of mechanisms characterized by a certain ‘uncoordinated interdependence’, in which ties among states influence states’ adoption or nonadoption of policies”.¹⁴⁶ As discussed below, policy diffusion may lead to learning and adaptation which can operate at the same time and which also occur in some other networks: adaptation occurs when another state’s adoption of a policy “alters the value of the practice (thus implying instrumental motives for imitation)”, while learning occurs when “another’s adoption imparts information (thus implying functional motives for imitation)”.¹⁴⁷ A state’s adoption of CBDC may impart information for other states and alter the value of CBDC practice.

1. Learning

The CBDC network may facilitate the learning processes of different economies, however such an outcome will face serious challenges. Various central banks are closely watching the future development of CBDC, including the implication and regulation of CBDC by other jurisdictions, as a way to learn from others’ experiences. CBDC issuance and wide circulation necessitate changes to “the monetary, central bank, financial, contract, property, insolvency, and tax laws”,¹⁴⁸ including payment systems and settlement finality law, privacy and data protection law.¹⁴⁹ Moreover, the regulation of CBDC, when compared with paper currency, would apply to an even wider range of actors, including data service suppliers, firms maintaining applications, and suppliers of point of sale devices to initiate and accept payments.¹⁵⁰ All of these considerations require that implementers of CBDC gather a broad range of information and knowledge.

¹⁴⁴ Hafner-Burton, et al., INTERNATIONAL ORGANIZATION, 568 (2009).

¹⁴⁵ Fabrizio Gilardi & Fabio Wasserfallen, *The Politics of Policy Diffusion*, 58 EUROPEAN JOURNAL OF POLITICAL RESEARCH 1245, 1245 (2019).

¹⁴⁶ Elkins, 46. 2009.

¹⁴⁷ Id. at, 47-48, 61.

¹⁴⁸ International Monetary Fund inter-departmental staff team, POLICY PAPER NO.2020/050, 31 (2020).

¹⁴⁹ Bossu, et al., IMF WORKING PAPER NO. 2020/254, 5 (2020).

¹⁵⁰ Bank of Canada, et al., 4 (2020).

The CBDC network could support the learning of different actors in respect of CBDC and related issues, provided that potential challenges can be addressed. Learning involves many considerations including technological design and legal arrangements. Forms of learning could range from the identification of the challenges and implications of CBDC, to information sharing on best practices. This seems to be the case with at least some of other networks. If properly managed, many networks could supply information and promote learning.¹⁵¹ Learning could then usefully inform the decision-making of different actors.

Learning may not, however, be a smooth process and the information flow may face serious challenges, such as its possible manipulation as well as limitations and biases in the learning process (e.g., difficulties in assessing the implications of country A's model for country B, and the insufficient observation of long-term trends).¹⁵² There is the potential that actors might manipulate the information flow given the possible conflicting preferences of different nodes.¹⁵³ As an example of limitations in the learning process, an early failure of a project may lead others to reject any project of its kind, while “[l]ong-term trends or low-profile cases—both of which are less ‘available’—will have less of an impact”.¹⁵⁴

Even access to information itself could be challenging, and a policy's availability may distort the learning process (such as the disproportionate weight likely be given to prominent nations' policies).¹⁵⁵ Sharing regarding technology and data underlying CBDC is not easy. The technology underlying CBDC would involve patents, and data is often deemed as sensitive. Given the vital role of the monetary system, some countries might consider the relevant technology and data to involve national security issues. Further, access to information is not equal across all states. The learning process 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 such 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.¹⁵⁶ Nodes with “high closeness or information centrality” obtain information “more quickly than marginal nodes”.¹⁵⁷ Eventually, there is the issue of “the likelihood of information actually passing along particular ties (proportional to their

¹⁵¹ Hafner-Burton, et al., INTERNATIONAL ORGANIZATION, 573 (2009).

¹⁵² Elkins, 53, 54. 2009.

¹⁵³ Lake & Wong, *The Politics of Networks: Interests, Power and Human Rights Norms* 131. 2009.

¹⁵⁴ Elkins, 55. 2009.

¹⁵⁵ *Id.* at, 53-55.

¹⁵⁶ Hafner-Burton, et al., INTERNATIONAL ORGANIZATION, 564 (2009).

¹⁵⁷ *Id.* at, 568-569.

strength)”, which is regarded as information centrality.¹⁵⁸ For instance, smaller states may not have many direct connections with larger states, or may encounter resource limitations (such as capacity limits). It remains to be seen whether these challenges can be overcome.

A CBDC network, given its likely overall approach as a network-as-structure, would bring with it a competition of ideas. This would provide more options when a jurisdiction has to make its decision on CBDC but may also make the choice an uneasy one. Such options would likely concern, among other factors, the regulatory approaches to be adopted alongside CBDC. To illustrate, the legal status of digital tokens under public and private law is far from clear, and there are proposals regarding various approaches towards their conceptualization.¹⁵⁹

Furthermore, the competition of ideas would also involve the different CBDC categories and technical designs. Given the varieties of CBDC and technical designs, learning will be integral to the development of the network. In particular, different CBDC category and technical designs would have regulatory implications. To illustrate, if states choose an account-based CBDC or digital tokens, it is challenging to create “an effective anti-money laundering and know your customer framework on a tokenized system”.¹⁶⁰ This may affect the use of these CBDCs internationally.

Overall, at the early stage, various ideas will likely compete for acceptance in the network, especially because it is difficult to determine the quality of a norm before it is manifested in practice.¹⁶¹ The information provided by different actors in the CBDC network would likely inform or affect the decisions of other states. For example, there could be learning regarding the solutions to potential challenges faced by encryption,¹⁶² risk control measures to protect data privacy (e.g., fighting against privacy leakage), amendments regarding wrong transactions, and contingency plans in the case of a system failure.¹⁶³

¹⁵⁸ Id. at, 565.

¹⁵⁹ Bossu, et al., IMF WORKING PAPER NO. 2020/254, 9, 11 (2020).

¹⁶⁰ Raghuvveera & Bray. 2020.

¹⁶¹ Lake & Wong, *The Politics of Networks: Interests, Power and Human Rights Norms* 128. 2009.

¹⁶² For instance, there is a debate on whether quantum computing may break encryption that is not only relevant to private digital currency but also CBDC. See, e.g., George V. Hulme, *Soon, Quantum Computing Could Break Your Encryption* (2021), available at <https://securityboulevard.com/2021/01/soon-quantum-computing-could-break-your-encryption/>; Roger Huang, *Here's Why Quantum Computing Will Not Break Cryptocurrencies* (2020), available at <https://www.forbes.com/sites/rogerhuang/2020/12/21/heres-why-quantum-computing-will-not-break-cryptocurrencies/?sh=69e3e60167b5>.

¹⁶³ Xiaochuan Zhou, *Understanding China's Central Bank Digital Currency* (2020), available at http://www.cf40.com/en/news_detail/11481.html.

2. Adaptation

The network effects of adaptation may arise, which would involve competitive adaptation regarding CBDC. Different countries issuing CBDCs will develop their own CBDC policies. However, the adoption of a CBDC in one economy, particularly a major economy, will affect other economies' attitudes towards a CBDC given various factors, chief among them competition among currencies. 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.¹⁶⁴ In other words, a major economy's decision to adopt a CBDC (an adopter) will change the conditions in which other jurisdictions make their choices.

Due to adaptation, states in the CBDC network may behave instrumentally: 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 own competitiveness (as reflected in similar situations like the liberalization regarding capital account, and exchange rates).¹⁶⁵ These elements also include the performance of the nodes in the CBDC network, and the avoidance of obsolescence in a digital age. CBDC issued by major economies like China, along with Libra as a global stablecoin, may speed up the process of some countries in considering CBDC.

For the elements of competitive equilibrium, it is expected that monetary competition through the CBDCs of major economies “will be the defining development of the next decade”.¹⁶⁶ It is observed that once fiat currency becomes digital, these currencies will compete with each other.¹⁶⁷ CBDC will affect currencies' international role and have implications for world economy such as international payments.¹⁶⁸ An impetus for issuing CBDCs is to avoid obsolescence in a digital age. It is observed that important considerations in respect of CBDC include “coordination with possible advances in this field made by other countries” and “adaptation with the advanced technological environment”.¹⁶⁹ Similar to other networks, there are also first mover advantages in relation to the facilities of CBDC, such as the development and control of essential facilities that will provide leverage over other actors in the network.¹⁷⁰ The leading nations issuing CBDC may export their technology to other countries, particularly those lacking sufficient capacity. This is reflected in the statement of

¹⁶⁴ Elkins, 49. 2009.

¹⁶⁵ *Id.* at, 49, 51.

¹⁶⁶ Didenko, et al., EUROPEAN BANKING INSTITUTE WORKING PAPER SERIES 65/2020, 5 (2020).

¹⁶⁷ Yeung. 2020.

¹⁶⁸ Auer, et al., BIS WORKING PAPERS NO 880, 3 (2020).

¹⁶⁹ The Bank of Israel, 3 (2018).

¹⁷⁰ Cowhey & Mueller, 180. 2009.

François Villeroy de Galhau, the Governor of the Bank of France: “I see 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]”.¹⁷¹ The decisions of the first major movers could strongly affect the choices of peers.

As another element, states are likely to consider issuing CBDC and joining a CBDC cluster due to other network externalities. These network externalities include the crucial role of CBDCs in the world economy, the mutual support that may be available in a CBDC cluster, and efficiency in a digital age if everything goes smoothly. For instance, more states will tend to join the CBDC network if it or some of its cluster(s) becomes dominant in the international financial system (e.g., if there is a large number of CBDC users). A central bank would likely observe the practice of other CBDCs in order to respond flexibly to developments in crucial areas like international payments.¹⁷²

Policy diffusion is a mixed bag. Networks may promote information flow, and the competition of ideas that may help to identify certain good practices and solutions to potential challenges. However, they are not without challenges, including the possible manipulation of information flow. Only with time will we be able to see how the information will flow and be processed in respect of CBDCs.

B. Cooperation and Conflict

A CBDC network would bring both cooperation and conflict in CBDC regulation. As with other networks, cooperation and conflict provide another perspective to explore network effects, and such cooperation and conflict would be affected by network dynamics.¹⁷³

1. Cooperation

Cooperation by actors in the CBDC network is desirable. Competitive adaptation may reveal the need for cooperation to “avoid the drift to suboptimal outcomes”.¹⁷⁴ There are calls for international cooperation regarding CBDC¹⁷⁵ due to, inter alia, cross-border linkages in monetary and payments systems.

Cooperation would promote financial stability. To illustrate, it is predicated that “[a] CBDC of one jurisdiction could impact on another’s monetary policy or financial stability (eg

¹⁷¹ Raghuvveera & Bray. 2020.

¹⁷² Bank of Japan, 15-16. 2020.

¹⁷³ Hafner-Burton, et al., INTERNATIONAL ORGANIZATION, 569 (2009).

¹⁷⁴ Elkins, 62. 2009.

¹⁷⁵ See, e.g., Reuters Staff, *Bank of Canada Says Global Approach Needed on Digital Currencies, Working With G7*(2020), available at <https://www.reuters.com/article/idUSKBN27D3AQ>.

through “dollarisation”).¹⁷⁶ In the same vein, “a poorly designed CBDC issued in one jurisdiction could create financial stability issues in another jurisdiction”, and a cyberattack on a CBDC arrangement in one nation could affect other linked economies “if confidence in certain technologies or payment mechanisms is eroded”.¹⁷⁷ A crisis regarding a CBDC issued by one country could lead to serious damages to the network and likely affect the confidence in CBDC issued by other states. Cooperation helps to improve the design of CBDC and address issues that could trigger a crisis.

Cooperation would have other benefits, such as promoting connections among CBDCs (including data flow, standardization of IT on CBDC, and other issues related to interoperability), and addressing fluidity, complexity (like technology advancement) and other dynamics or risks faced by the international monetary system. Cooperation will be useful for anti-money laundering and combating the financing of terrorism (AML/CFT) measures. It is observed that “there will likely be calls for policy makers to harmonize legal and regulatory frameworks governing data use and sharing, competition policy, consumer protection, digital identity, and other important policy issues relating to the digital economy.”¹⁷⁸ Cooperation has other benefits such as producing a better understanding of the distributive effects, international as well as domestic, of CBDC.

However, the likely structure of a CBDC network as a decentralized network with predominant elements of a networks-as-structure would make it difficult to facilitate network-wide, deep cooperation. CBDC considerations substantially diverge and can change over time. There are uncertainties regarding these considerations. Uncertainties exist in respect of internal (e.g., CBDC operation) and external (e.g., world economy) aspects. Concerning internal aspects, a state’s interests are likely to be uncertain because of “inadequate information about the situation at hand” or “doubt about the likely outcomes of different courses of action”.¹⁷⁹ Regarding external factors, the shifting geopolitical dynamics would affect states’ considerations on CBDC and international cooperation. For example, some CBDCs may involve the response to economic sanctions (as the case with Venezuela that will be discussed below), and the coordination between states that impose and respond to sanctions would be very difficult.

¹⁷⁶ Bank of Canada, et al., 17 (2020).

¹⁷⁷ Lael Brainard, *An Update on Digital Currencies*(2020), available at <https://www.federalreserve.gov/newsevents/speech/files/brainard20200813a.pdf>.

¹⁷⁸ International Monetary Fund inter-departmental staff team, POLICY PAPER No.2020/050, 8 (2020).

¹⁷⁹ Mette Eilstrup-Sangiovanni, *Varieties of Cooperation: Government Networks in International Security*, in NETWORKED POLITICS: AGENCY, POWER, AND GOVERNANCE 207, (Miles Kahler ed. 2009).

Cooperation, particularly deep cooperation, is more likely to occur among a small number of actors with similar interests or structural positions. This is supported by the fact that discussion on CBDCs appears to often occur among a smaller number of countries than at a broader international level. Cooperation on CBDC research has taken place between central banks and international organizations. There have been bilateral experiments which have indicated the feasibility of CBDCs being used for international payments.¹⁸⁰ One example is Stella, a project jointly initiated by the ECB and Bank of Japan, which is concerned with whether DLT has the potential to replace RTGS.¹⁸¹ It is observed that “[p]rogress has accompanied a gradual convergence on definitions and terms and an improved understanding of the capabilities of current technologies”.¹⁸² There is also “the CBDC coalition of central banks”, which involves a small number of central banks such as the Federal Reserve.¹⁸³ These central banks have created a group with the BIS to share their experience in assessing the potential case for CBDC, including cross-border interoperability.¹⁸⁴ Moving beyond conceptual research, a group of central banks now emphasize practical policy development as well as technical experiments.¹⁸⁵ They are exploring a series of collaborations (such as on the common principles and key features of CBDCs).¹⁸⁶ Their common motivation is to “avoid[] unintended barriers for transferring sovereign currencies in their electronic forms”,¹⁸⁷ and explore “a general purpose CBDC is its use as a means of payment”.¹⁸⁸ Meanwhile, there is the Central Bank Governors’ Club, whose recent meeting, chaired by the Bank of Russia Governor Elvira Nabiullina, discussed CBDCs.¹⁸⁹ The Central Bank Governors’ Club includes “representatives of 26 central banks of the Central Asia, Black Sea Region and Balkan Countries”, including China.¹⁹⁰ Representatives from the IMF and BIS also participated in the discussion in this meeting.¹⁹¹ Deep collaboration, however, appears to be limited to a number of central banks. For instance, as has been noted earlier, China is

¹⁸⁰ Bank of Canada, et al., 7 (2020).

¹⁸¹ Qian Yao, *A Systematic Framework to Understand Central Bank Digital Currency*, 61 SCIENCE CHINA INFORMATION SCIENCES 1, 4 (2018).

¹⁸² Bank of Canada, et al., 16 (2020).

¹⁸³ Brainard, 4. 2020.

¹⁸⁴ Bank of England, *Central Bank Group to Assess Potential Cases for Central Bank Digital Currencies*(2020), available at <https://www.bankofengland.co.uk/-/media/boe/files/news/2020/january/central-bank-group-to-assess-potential-cases-for-central-bank-digital-currencies.pdf>.

¹⁸⁵ Bank of Japan, 19. 2020.

¹⁸⁶ Bank of Canada, et al., 1 (2020).

¹⁸⁷ Yeung, 2020.

¹⁸⁸ Bank of Canada, et al., 1 (2020).

¹⁸⁹ Bank of Russia, *Central Bank Governors Discuss Pandemic's Effects and Digital Currencies Issues*(2020), available at <https://www.cbr.ru/eng/press/event/?id=8249>.

¹⁹⁰ Id. at.

¹⁹¹ Id. at.

reportedly absent from the international group consisting of a number of advanced economies.¹⁹² There is a possibility that different groups may represent small clusters within the network in the future. As discussed above in respect of network structure, nodes in similar structural positions vis-à-vis other nodes are expected to act in similar ways.¹⁹³ Resembling other networks,¹⁹⁴ the CBDC network may start as a self-enforcing network that is built on reciprocity, and a small cluster of actors could emerge that cooperate and have arguably a collective voice on CBDC.

2. Conflict

Conflict including incompatibility would likely arise in the CBDC network. It could involve the choice of CBDC model, particularly policy and technical design, including “architectures, infrastructures, access and interlinkages”.¹⁹⁵ The uncoordinated network-as-structure approach of CBDC network makes it more difficult to address possible conflict.

Different technologies, systems and standards adopted for different CBDCs may give rise to compatibility issues. Overall, uniform specification for CBDC is lacking among the countries that have launched pilot CBDC programs, and those that have investigated potentially launching a CBDC.¹⁹⁶ Such a lack of uniform specification involves CBDC accessibility (to the general public or only to financial institutions), issuance (token-based or balance-based), anonymity in the use of CBDC, and interest borne with CBDC (or not).¹⁹⁷

Conflict would likely exist in respect of crucial issues like data and privacy protection, legal restrictions related to the use of CBDC,¹⁹⁸ and the relationship between efficiency and safety in the case of conflict (such as speedy processing versus stronger security that increases processing time¹⁹⁹). For instance, cross-border payments would face challenges of divergent legal and regulatory frameworks,²⁰⁰ such as those related to data. Taking the regulation of essential facilities as another example, there could be different requirements on open digital wallets, and different approaches regarding whether and under what specific circumstances a third party may freeze assets.²⁰¹

¹⁹² Yeung, 2020.

¹⁹³ Hafner-Burton, et al., INTERNATIONAL ORGANIZATION, 567 (2009).

¹⁹⁴ Lake & Wong, *The Politics of Networks: Interests, Power and Human Rights Norms* 133, 135. 2009.

¹⁹⁵ Auer, et al., BIS WORKING PAPERS NO 880, 1, 28 (2020).

¹⁹⁶ The Bank of Israel, 8 (2018).

¹⁹⁷ *Id.* at, 2.

¹⁹⁸ PHOEBUS L. ATHANASSIOU, *DIGITAL INNOVATION IN FINANCIAL SERVICES: LEGAL CHALLENGES AND REGULATORY POLICY ISSUES* 204 (Kluwer Law International. 2018).

¹⁹⁹ Bank of Canada, et al., 15 (2020).

²⁰⁰ *Id.* at, 7.

²⁰¹ Binance Research (Jinze & Etienne), *First Look: China's Central Bank Digital Currency*, (2019).

Conflict would negatively affect network efficiency and the network's capacity to withstand possible disruption. Potential issues include increased compliance costs, regulatory arbitrage, the avoidance of rules, and the vulnerability to cyber-attack. For instance, it is predicted that a CBDC of one state may be "used to avoid laws and regulations outside a jurisdiction where sufficient controls are not in place."²⁰² Due to the possibility of conflict, it remains to be seen whether a stable relationship among CBDC actors would be maintained.

Why is there the potential for conflicts in respect of CBDC? There are many different reasons, problematizing the provision of an exhaustive list. Different capacities (e.g., technological capacity) and different motivations regarding CBDC are among the major reasons for possible conflict. They are crucial attributes of nodes. In fact, CBDC projects "differ starkly" in respect of motivations and technical design.²⁰³ The learning process can hardly be expected to bring convergence particularly given such vast differences among states.

Regulators are likely to encounter inadequate technical resources, experience and expertise to address numerous technical questions (e.g., the use of DLT or not, algorithm, cybersecurity protections, and the rectification of erroneous payments).²⁰⁴ CBDCs involve complex traditional issues (particularly monetary sovereignty as is the case with paper currency) and new issues (particularly technology, data, and a likely CBDC-related digital identity system²⁰⁵). Such complexity sets high requirements for the capacity of governments, and makes conflict likely to arise. To illustrate, technical issues range from resilience and bandwidth to scalability and transaction speed.²⁰⁶ It is challenging to address the interoperability of different CBDCs including the need for essential facilities. For instance, capacity limit affects the interoperability of essential facilities of CBDC (like the connections among CBDCs, and the local access facilities to CBDCs). As with many other networks, essential facilities would serve as control points and points of vulnerability for the network.²⁰⁷

Different motivations, including incentives, are likely to cause conflict. Strategic reasons and mixed incentives could exist in a network and lead to incompatibility (in the form of no adoption of homogeneous standards).²⁰⁸ Given the possible conflicting preferences of

²⁰² Bank of Canada, et al., 17 (2020).

²⁰³ Auer, et al., BIS WORKING PAPERS NO 880, 3, 28 (2020).

²⁰⁴ Didenko, et al., EUROPEAN BANKING INSTITUTE WORKING PAPER SERIES 65/2020, 36 (2020).

²⁰⁵ Bank of Canada, et al., 7 (2020).

²⁰⁶ Raghuvveera & Bray. 2020.

²⁰⁷ Cowhey & Mueller, 178. 2009.

²⁰⁸ Id. at, 179-180.

different nodes, there is even the possibility that actors may manipulate network structure.²⁰⁹ Motivations regarding CBDC are affected by a country's socio-economic, technological and even geo-economic situation.²¹⁰ The motivations concern many regulatory issues, including: (i) payment (e.g., access to central bank money, promotion of fiscal transfers, resilience, diversity of payment, financial inclusion, international payments, and privacy); (ii) monetary policy (e.g., direct transfers to the public), and (iii) financial stability (e.g., possible disintermediation of banks, and monetary sovereignty).²¹¹ Here is one example. Differing from China's CBDC that is more of "a digital monetary framework to operate across existing payment systems", the Digital Dollar proposal appears to merge monetary and payment arrangements, which consist of a digital token (used in wholesale and retail transactions) and a universal account-based payment system (enabling each person to have his or her own account with the Federal Reserve).²¹² CBDC may affect the deposits in commercial banks, commercial bank money, and even the business model of commercial banks. This will likely entail different responses of states and different design and regulation of CBDC (such as the existence or not of limit on, and how much limit on, the amount of CBDC that an individual can use). More recently, the response to COVID-19 has become another consideration. Different motivations will likely lead to incongruence in the design of regulation, including the objectives of regulation, regulatory tools, and regulatory threshold (e.g., minimal standards), to name a few areas.

Potential divergent motivations include the relationship between CBDC and other currencies, data, capital control, and a response to economic sanctions. Different considerations exist regarding the relationship between CBDC and other currencies (e.g., Bitcoins, Libra), and more broadly the relationship between the government and private sectors in areas such as payment systems. Relating to financial stability, there are concerns that private digital currencies may negatively affect central banks' "control of flows of funds".²¹³ Compared with paper currency, CBDCs give more control to central banks in monitoring the use of currency.²¹⁴ However, countries are likely to have different ideas about CBDC. Some states may use CBDCs to "curb the growth of private payment providers and

²⁰⁹ Lake & Wong, *The Politics of Networks: Interests, Power and Human Rights Norms* 131. 2009.

²¹⁰ Taking Sweden as an example, the considerations of CBDC are related to concerns over loss of monetary sovereignty and the access of the poor and people living remotely to money. Didenko, et al., *EUROPEAN BANKING INSTITUTE WORKING PAPER SERIES 65/2020*, 42 (2020).

²¹¹ Bank of Canada, et al., 5-9 (2020).

²¹² Didenko, et al., *EUROPEAN BANKING INSTITUTE WORKING PAPER SERIES 65/2020*, 44, 49 (2020).

²¹³ John. 2020.

²¹⁴ Davoodalhosseini, et al. 2020.

cryptocurrencies, which they see as a competitive risk to central bank-issued cash”, and some economies are likely to be more interested in the role of CBDCs in advancing digital payments systems.²¹⁵ Canada seems to take a wait and see approach as it may consider issuing CBDC if its monetary sovereignty becomes vulnerable to “a private digital currency not denominated in Canadian dollars”.²¹⁶ Going further than Canada, China’s CBDC seemingly provides an alternative to private digital currencies and is expected to help China to strengthen regulation at home.²¹⁷

Data is another area in which divergent considerations can be found. Data is regarded as data sovereignty.²¹⁸ Divergent data regulation (e.g., data ownership, usage, flow, protection and privacy) and the lack of international coordination regarding data regulation add another layer of complexity to a CBDC network. It is observed that CBDCs “would allow for an unprecedented level of intrusion by a foreign central bank, which would have visibility into transactions well beyond what is possible with the US dollar-based system”, since foreign users of countries who have adopted another state’s CBDC-based payments system “could see their financial transactions being tracked and collected”.²¹⁹ CBDC is also connected with supplementary systems and data services (e.g., digital identity repositories).²²⁰ There are divergent “jurisdictional data requirements and data localization rules” in different nations,²²¹ and the practices of states may be rather different. One country may prioritize privacy of end-user information over efficiency regarding CBDCs if there is a conflict. In contrast, another country may take the opposite position. For instance, substantial differences are likely to exist between the US and China regarding data regulation such as data localization. These divergent rules would affect data regulation regarding CBDCs including the cross-border sharing of data.

Different motivations exist in respect of many other issues like capital control and economic sanctions. Regarding capital flow, it is reported that China could “want other countries to use the digital yuan so that it can trace and control capital flows into and out of the country more easily, via its own global payment platform”.²²² CBDC may also need to

²¹⁵ Raghuvveera & Bray. 2020.

²¹⁶ Bank of Canada, *Contingency Planning for a Central Bank Digital Currency*(2020), available at <https://www.bankofcanada.ca/2020/02/contingency-planning-central-bank-digital-currency/>.

²¹⁷ Karen Yeung, *What Is China’s Cryptocurrency Alternative Sovereign Digital Currency and Why Is It Not Like Bitcoin?*(2020), available at <https://www.scmp.com/economy/china-economy/article/3083952/what-chinas-cryptocurrency-sovereign-digital-currency-and-why>.

²¹⁸ See, e.g., Andrew Keane Woods, *Litigating Data Sovereignty*, 128 YALE LAW JOURNAL 328, 328-406 (2018).

²¹⁹ Raghuvveera & Bray. 2020.

²²⁰ Bank of Canada, et al., 7 (2020).

²²¹ Dirk A Zetsche, et al., *Decentralized Finance*, 6 JOURNAL OF FINANCIAL REGULATION 172, 190 (2020).

²²² Yeung, *China Not Among Major Central Banks in Talks on Global Digital Currency Principles*. 2020.

link to foreign exchange systems that vary from one country to another.²²³ Some economies have free-floating currencies while others do not. Regarding the possible circumvention of financial sanctions, Venezuela launched a government-backed cryptocurrency in 2018, largely due to financial sanctions imposed by the US.²²⁴ The currency was intended to attract foreign investors and capital inflows that would bypass governments, but so far this seemingly has not happened and Venezuela is suffering from increasing financial and economic difficulties.²²⁵ As another example, CBDC may be used for “combating the unreported economy”.²²⁶ States may also highlight different, specific aspects of CBDC, such as monetary sovereignty, exchange rate regime and the regulation of currency exchange,²²⁷ international trade payment, settlement and payment in the financial market, or cross-border remittance.²²⁸ These factors would affect the promotion of CBDC by different states,²²⁹ and likely to lead to different regulatory systems (such as the regulation on foreign users of CBDC, and whether and how foreign exchange transactions related to CBDC are allowed).

These differences in capacities and motivations would affect the regulatory design, and practice. Different states could impose various restrictions (e.g., stringent policy on the use of CBDC based on their favoured criteria) on their CBDCs. Besides capacities, such incongruency of motivations is likely to lead to conflict in the CBDC network when one comes to numerous issues, including data regulation and even interoperability.

IV. THE IMPACT OF CBDC NETWORK ON THE GFN: FROM A CENTRALIZED GFN TO A FLAT ONE?

What shape would the relationship between the CBDC network and the GFN take? Approximating other networks, the CBDC network will likely become part of the GFN as a result of technological advancements like FinTech, economic connection, and the need for international cooperation.²³⁰ The future GFN can thus be predicted to expand to encompass CBDC.

What would the effect of the CBDC network on the GFN be? Essentially, the structure of the CBDC network will determine its effect on the GFN. If the structure of the CBDC

²²³ Raghuvveera & Bray. 2020.

²²⁴ The Bank of Israel, 14 (2018).

²²⁵ Id. at.

²²⁶ Id. at, 3.

²²⁷ Zhou. 2020.

²²⁸ Boao Forum for Asia, *ZHOU Xiaochuan: Sino-Singapore Digital Currency Cooperation Could Start From Retail*(2020), available at https://mp.weixin.qq.com/s/7Gweq4oP_EwKviqR281Qbg.

²²⁹ Zhou. 2020.

²³⁰ Kahler, 1. 2009.

network is similar to the GFN (including the position of nodes in the network), it would likely strengthen the structure of the existing GFN. Otherwise, the CBDC network may instead change the structure of the GFN. The key is whether the positions of actors in the GFN are likely to be strengthened or weakened by CBDC.

The GFN is currently a centralized system. The US is the most important node and sits at the center of the GFN due to the lack of alternatives,²³¹ while emerging economies (including China as the world's second largest economy) are currently not among the top nodes.²³² An actor is affected by its location in the GFN and its relationship with other actors (such as the potential for competition among CBDCs, and competition between CBDCs and private digital currencies), which in turn affect the network. Alongside deep changes, particularly those following the Global Financial Crisis, the GFN's structure is considered to be incrementally developing from a centralized one to a flat one (such as the BRICs, or "a US-EU condominium" with the potential of incrementally replacing the American centrality²³³).²³⁴ There is a call for building a multipolar system in the GFN, and technology advancement (e.g., the network of CBDCs as a "new Synthetic Hegemonic Currency (SHC)") may enable this multipolar system to emerge.²³⁵

CBDC is likely to affect power differentials in the GFN. On the one hand, it is possible that the future GFN will increasingly move towards a decentralized network and away from a centralized one. CBDC, along with other digital currency particularly Libra, has "the potential to fragment the global monetary and financial system into competing major currency blocks."²³⁶ CBDC is likely to reduce reliance on the existing infrastructure (like SWIFT, and "the reach of economic sanctions").²³⁷ As discussed above, the CBDC network is likely to be a decentralized network, which could push the GFN towards becoming more decentralized. It is likely that the GFN, after the emergence of CBDCs, will not be the same "strongly hierarchical network" as before.²³⁸

On the other hand, there are uncertainties regarding whether the GFN will eventually shift to a flat one even with the emergence of CBDCs. First, if the US introduces a digital dollar,

²³¹ Oatley, et al., PERSPECTIVES ON POLITICS, 148 (2013).

²³² Sarpong & Deodutt, COGENT ECONOMICS & FINANCE, 4 (2019).

²³³ Oatley, et al., PERSPECTIVES ON POLITICS, 134, 146 (2013).

²³⁴ Sarpong & Deodutt, COGENT ECONOMICS & FINANCE, 10 (2019).

²³⁵ Mark Carney, *The Growing Challenges for Monetary Policy in the Current International Monetary and Financial System*, Speech Given by Mark Carney, Governor of the Bank of England, 14 (2019).

²³⁶ Didenko, et al., EUROPEAN BANKING INSTITUTE WORKING PAPER SERIES 65/2020, 5 (2020).

²³⁷ Samuel Haig, *JP Morgan: CBDC Threatens Hegemony of US Dollar* (2020), available at <https://cointelegraph.com/news/jp-morgan-cbdc-threatens-hegemony-of-us-dollar>.

²³⁸ Oatley, et al., PERSPECTIVES ON POLITICS, 135 (2013).

this would very likely slow down the shift towards a flat network. The US is considering introducing a digital dollar to respond to the COVID-19 crisis at the time of writing.²³⁹ It remains to be seen whether the proposal will be put into effect and, if so, how it will affect the monetary system. This will have an impact on whether the shift of the GFN towards a flat network will continue and to what extent. At the least, it is unlikely that the US dollar will lose its dominant position in the short term.

Second, the future GFN network, even if it becomes a flat one, may still be subject to hierarchical control. As with other networks, the GFN is affected by various elements ranging from physical limitations (connection facilities) to costs and coordination challenges (like international coordination).²⁴⁰ Over time, the CBDC network is likely to develop into a scale-free network like an airline system, in which a few nodes (the frequently used CBDCs) are linked to a large number of other nodes (such as small economies whose CBDCs are less frequently used) that are not highly interconnected.²⁴¹ When entering into a scale-free network, new nodes are likely to establish connection with already well-connected nodes.²⁴² Relatedly, there could be “digital dollarisation” if foreign CBDCs are often used by domestic users.²⁴³

Third, if the GFN becomes a flat network, it may stabilize if everything goes smoothly, or become disordered and even potentially return to a centralized network if the flat structure does not work. To illustrate, CBDC may affect financial stability. For example, the IMF has issued a report stating that if Marshall Islands issues a digital currency to serve as legal tender in parallel with the US dollar, it could “lead to financial instability and even cause harm to cooperation with the large American banks”.²⁴⁴ Risks will spread across borders particularly when CBDC is used internationally. The effects of risks depend on the ties between states in terms of currency, including the strength of such ties. A flat network may bring more risk contagion by different actors than a centralized one. Also, the growth of the GFN (particularly with the possible international use of CBDC) is likely to resemble other networks in terms of adding network complexity and demanding “structural changes in administration that fundamentally alter its character”.²⁴⁵

²³⁹ Brett. 2020.

²⁴⁰ Cowhey & Mueller, 179. 2009.

²⁴¹ Lake & Wong, *The Politics of Networks: Interests, Power and Human Rights Norms* 129. 2009.

²⁴² Janice Gross Stein, *The Politics and Power of Networks: The Accountability of Humanitarian Organizations*, see id. at 155, (

²⁴³ Bank of Canada, et al., 8 (2020).

²⁴⁴ The Bank of Israel, 14 (2018).

²⁴⁵ Cowhey & Mueller, 178. 2009.

Essentially, the development of both a CBDC network and the GFN are dynamic processes, and their future remains unclear. For instance, it remains to be seen whether the resource flow in the network will be controlled by one or more nodes, and how the preferences behind various CBDCs will be addressed in the networks. Both networks would probably encounter serious challenges in rulemaking and international cooperation.

V. CONCLUDING REMARKS

Bringing new payment infrastructures and arrangements, CBDCs are likely to form a network that significantly affects the international monetary system in the long run. This is due to CBDC's nature, as involving not only currency but also data. However, its international dimension and profound implications are not fully explored. CBDC will be a game changer in the international financial system, and in all likelihood will trigger greater currency competition. The CBDC network will likely be a decentralized network, and as a whole adopt the approach of an uncoordinated network-as-structure rather than a network-as-actor.

The CBDC network would bring profound implications for regulation at the international level. The CBDC network is likely to bring policy diffusion effects (learning and adaptation) but not necessarily lead to convergence. States in the CBDC network can be predicted to behave instrumentally. Moreover, the CBDC network would bring limited cooperation and face more conflict. The conflict is likely to bring fragmentation in the international monetary system. Given the CBDC's disruptive effect, the objectives of central banks with CBDCs are probably not congruous with those of central banks without CBDCs.²⁴⁶

The CBDC network, as a decentralized network, is likely to affect power differentials in the GFN and could speed up the shift of the GFN towards a flat network. However, there are uncertainties such as the possible digital dollar and "digital dollarisation". It remains to be seen how the relations among nodes will develop in a CBDC network and the GFN, which are subject to many factors including geo-economic and geopolitical ones. Actors in the network are likely to seek to "increase their power by enhancing and exploiting their network positions".²⁴⁷

Regulatory response to the risks in the CBDC network is crucial. Foremost, it is crucial to address conflict in the CBDC network to avoid a lose-lose outcome. It is argued that "[r]egardless of the motivation, any approach to issuing a CBDC will naturally be cautious,

²⁴⁶ Didenko, et al., EUROPEAN BANKING INSTITUTE WORKING PAPER SERIES 65/2020, 35 (2020).

²⁴⁷ Hafner-Burton, et al., INTERNATIONAL ORGANIZATION, 559 (2009).

incremental and collaborative”.²⁴⁸ In particular, international organizations are important for promoting cooperation and could be a kind of international hub for CBDC cooperation given, among other factors, legitimacy and pathway dependence. International organizations have a role to play such as their efforts to promote the flow of information (including best practices, knowledge sharing) and effectively consult with stakeholders.²⁴⁹

Second, it is vital to avoid a race to the bottom in the CBDC network. Users may prefer to use the CBDC with the least regulatory requirements. Minimal regulatory standards are crucial for the CBDC network, including transparency. Given the difficulties in international coordination, the development of a code of conduct may be a first, albeit partial step to address major problems.²⁵⁰ This would enhance the predictability of the international economy.

Third, rules need to be developed with foresight to address potential issues. This differs from a responsive regulatory approach. Legal changes need to be prepared well in advance, including how to deal with foreign CBDCs, how accommodative the rules will be to foreign CBDCs, and how to ensure coherence with the exchange control mechanism if any.²⁵¹ One needs to find a balance between safety and efficiency.²⁵² Legal issues should be properly handled to develop “shared working norms” to ensure global financial stability.²⁵³ Essentially, the key in a CBDC network is to minimize risks (e.g., “negative international spillovers” of domestic CBDCs²⁵⁴) and ensure financial stability. Public policy objectives (such as financial inclusion) also need to be taken into account.

The structure of the CBDC network could enable or constrain actors involved in new payment infrastructures and arrangements, while the actors will in turn affect the network. As CBDCs and the CBDC network are a moving target, the trends, risks and international regulatory response of CBDC deserve close attention.

Advait Palepu, *The Bahamas Issues World's First Central Bank Digital Currency*(2020), available at <https://www.medianama.com/2020/10/223-bahamas-issues-central-bank-digital-currency/>.

Bryan Michael Galvan & Kelly Le, *China's New DCEP Could Fast-Forward the Nation into a Cashless Society*(2020),

²⁴⁸ Bank of Canada, et al., 17 (2020).

²⁴⁹ Elkins, 62. 2009.

²⁵⁰ Stein, 152. 2009.

²⁵¹ International Monetary Fund inter-departmental staff team, POLICY PAPER NO.2020/050, 31 (2020).

²⁵² Didenko, et al., EUROPEAN BANKING INSTITUTE WORKING PAPER SERIES 65/2020, 10-14 (2020).

²⁵³ Raghuvveera & Bray. 2020.

²⁵⁴ Bank of Canada, et al., 2 (2020).

available at <https://forkast.news/china-dcep-accelerate-nation-cashless-society-privacy-digital-currency/>.

Wouter Bossu, et al., *Legal Aspects of Central Bank Digital Currency: Central Bank and Monetary Law Considerations*, IMF WORKING PAPER NO. 2020/254 (2020).

Karen Yeung, *China Not Among Major Central Banks in Talks on Global Digital Currency Principles*, South China Morning Post(2020), available at https://www.scmp.com/economy/china-economy/article/3104905/china-not-among-major-central-banks-talks-global-digital?utm_medium=email&utm_source=mailchimp&utm_campaign=enlz-scmp_china&utm_content=20201009&tpcc=enlz-scmp_china&MCUID=b2992489b1&MCCampaignID=c2e928c32f&MCAccountID=3775521f5f542047246d9c827&tc=5.

China Aims to Launch the World's First Official Digital Currency, The Economist(2020), available at <https://www.economist.com/finance-and-economics/2020/04/23/china-aims-to-launch-the-worlds-first-official-digital-currency>.

Bank of Canada, et al., *Central Bank Digital Currencies: Foundational Principles and Core Features*, (2020).

Jason Brett, *How Project Libra And COVID-19 Drove Digital Dollar Idea In Congress*(2020), available at <https://www.forbes.com/sites/jasonbrett/2020/04/24/how-project-libra-and-covid-19-drove-digital-dollar-idea-in-congress/#3e5134702c51>.

Raphael Auer, et al., *Rise of the Central Bank Digital Currencies: Drivers, Approaches and Technologies*, BIS WORKING PAPERS NO 880 (2020).

Qian Yao, *Technological Considerations of Central Bank Digital Currency*, Yicai(March 6, 2018), available at <https://www.yicai.com/news/5404436.html>.

Emilie M. Hafner-Burton, et al., *Network Analysis for International Relations*, 63 INTERNATIONAL ORGANIZATION 559(2009).

Thomas Oatley, et al., *The Political Economy of Global Finance: A Network Model*, 11 PERSPECTIVES ON POLITICS 133(2013).

Sebastian Poledna, et al., *The Multi-Layer Network Nature of Systemic Risk and Its Implications for the Costs of Financial Crises*, 20 JOURNAL OF FINANCIAL STABILITY 70(2015).

Stephen O'Neal, *Global Compatibility Is a Key Factor in the CBDC Race, Says Expert*(2020), available at <https://cointelegraph.com/news/global-compatibility-is-a-key-factor-in-the-cbdc-race-says-expert>.

Peter Cowhey & Milton Mueller, *Delegation, Networks, and Internet Governance*, in NETWORKED POLITICS: AGENCY, POWER, AND GOVERNANCE (Miles Kahler ed. 2009).

Franklin Allen & Ana Babus, *Networks in Finance*, WHARTON FINANCIAL INSTITUTIONS CENTER WORKING PAPER NO. 08-07 1.

Bank for International Settlements, *Central Bank Digital Currencies*, (2018).

Hossein Nabilou & André Prüm, *Central Banks and Regulation of Cryptocurrencies*, UNIVERSITY OF LUXEMBOURG LAW WORKING PAPER NO. 2019-014 1(2019).

Philip Lowe, *An eAUD?*, (2017).

Tony Richards, et al., *Retail Central Bank Digital Currency: Design Considerations, Rationales and Implications*, THE BULLETIN (2020).

Norges Bank, *Central Bank Digital Currencies*, NORGES BANK PAPERS (2018).

Sayuri Shirai, *Money and Central Bank Digital Currency*, ADBI WORKING PAPER SERIES NO. 922 (2019).

Bank of Japan, *The Bank of Japan's Approach to Central Bank Digital Currency*(2020), available at https://www.boj.or.jp/en/announcements/release_2020/data/rel201009e1.pdf.

Hossein Nabilou, *Central Bank Digital Currencies: Preliminary Legal Observations*, JOURNAL OF BANKING REGULATION (2019).

Nikhil Raghuvvera & David Bray, *Design Choices of Central Bank Digital Currencies Will Transform Digital Payments and Geopolitics*, Atlantic Council(2020), available at <https://www.atlanticcouncil.org/blogs/geotech-cues/design-choices-of-central-bank-digital-currencies-will-transform-digital-payments-and-geopolitics/>.

Ping Xie, *Ping Xie: After CBDC Infrastructure Is Developed, It Could Break Third-Party Payment Monopoly*(2020), available at <https://mp.weixin.qq.com/s/uHQs0mIPEZQle8R5xz6vfA>.

The Bank of Israel, *Report of the Team to Examine the Issue of Central Bank Digital Currency (CBDC)*, (2018).

The Reserve Bank of Australia, *Reserve Bank Partners With Commonwealth Bank, National Australia Bank, Perpetual and Consensus Software on Wholesale Central Bank Digital Currency Research Project*(2020), available at <https://www.rba.gov.au/media-releases/2020/mr-20-27.html>.

Ledger Insights, *Korea to Trial Blockchain for Its Central Bank Digital Currency*(2020), available at <https://www.ledgerinsights.com/korea-digital-won-blockchain-central-bank-digital-currency-cbdc/>.

Alun John, *Explainer: How Does China's Digital Yuan Work?*(2020), available at

<https://www.reuters.com/article/us-china-currency-digital-explainer-idUSKBN27411T>.

Codruta Boar, et al., *Impending Arrival – A Sequel to the Survey on Central Bank Digital Currency*, BIS PAPERS NO 107 (2020).

David A. Lake & Wendy H. Wong, *The Politics of Network: Interests, Power and Human Rights Norms*, in NETWORKED POLITICS: AGENCY, POWER, AND GOVERNANCE (Miles Kahler ed. 2009).

Stephen O'Neal, *State-Issued Digital Currencies: The Countries Which Adopted, Rejected or Researched the Concept*(2018), available at <https://cointelegraph.com/news/state-issued-digital-currencies-the-countries-which-adopted-rejected-or-researched-the-concept>.

Eswar Prasad, *Central Banking in a Digital Age: Stock-Taking and Preliminary Thoughts*, (April 2018).

Qian Yao, *The Past and Present of Digital Currency*, 2018 CHINA LAW REVIEW (2018).

Anton N. Didenko, et al., *After Libra, Digital Yuan and COVID-19: Central Bank Digital Currencies and the New World of Money and Payment Systems*, EUROPEAN BANKING INSTITUTE WORKING PAPER SERIES 65/2020 1(2020).

Nurjannah Ahmat & Sabrina Bashir, *Central Bank Digital Currency: A Monetary Policy Perspective*, BANK NEGARA MALAYSIA STAFF INSIGHTS 2017/11 (2017).

Report on a Digital Euro. (2020).

Christian Barontini & Henry Holden, *Proceeding With Caution – a Survey on Central Bank Digital Currency*, BIS PAPERS NO 101 (2019).

Yves Mersch, *Yves Mersch: An ECB Digital Currency – a Flight of Fancy?*(2020), available at <https://www.bis.org/review/r200511a.pdf>.

Mohammad Davoodalhosseini, et al., *CBDC and Monetary Policy*, Bank of Canada(2020), available at <https://www.bankofcanada.ca/2020/02/staff-analytical-note-2020-4/>.

Chen Jia, *China Promotes Global Digital Fiat Currency Standardization*(2018), available at http://english.www.gov.cn/state_council/ministries/2018/12/08/content_281476424565376.htm.

Miranda Wood, *How China's Central Bank Digital Currency Will Help Renminbi to Challenge Dollar*(2019), available at <https://www.ledgerinsights.com/china-central-bank-digital-currency-cbdc-renminbi-dollar/>.

Nicholas L. Johnson, *What are Network Effects?*, available at <https://www.applicoinc.com/blog/network-effects/>.

Forkast.News, *China Hopes Its New Digital Currency Will Internationalize the RMB. When Might That Day Come?*(2020), available at <https://forkast.news/china-dcep-cbdc-digital-currency-rmb-yuan-zhiguo-he-podcast/>.

Hu Yue & Denise Jia, *China's Didi Teams with Central Bank on Digital Currency Trial*(2020), available at <https://asia.nikkei.com/Spotlight/Caixin/China-s-Didi-teams-with-central-bank-on-digital-currency-trial>.

International Monetary Fund inter-departmental staff team, *Digital Money Across Borders: Macro-Financial Implications*, POLICY PAPER NO.2020/050 (2020).

Deergha Raj Adhikari, *Has the Currency Swap Arrangement Affected the Value of Yuan?*, 8 INTERNATIONAL RESEARCH JOURNAL OF APPLIED FINANCE 12(2017).

Andrew Sheng, *Financial Crisis and Global Governance: A Network Analysis*, COMMISSION ON GROWTH AND DEVELOPMENT WORKING PAPER NO. 67 (2010).

Prince Kwasi Sarpong & Jugjith Deodutt, *Legal Theory of Finance: Evidence From Global Financial Networks*, 7 COGENT ECONOMICS & FINANCE (2019).

Yevgeniya Korniyenko, et al., *Evolution of the Global Financial Network and Contagion: A New Approach*, WORKING PAPER NO. 18/113 (2018).

Daryl Guppy, *The Future of China's Economic Engagement*(2020), available at <https://www.chinadaily.com.cn/a/202004/24/WS5ea28240a310a8b2411516bf.html>.

GeoEconomics Program and Belfer Center for Science and International Affairs, *The Rise of Central Bank Digital Currencies*(2020), available at <https://www.atlanticcouncil.org/blogs/econographics/the-rise-of-central-bank-digital-currencies/>.

MAD, *What is a CBDC or Central Bank Digital Currency?* (2020).

David A. Lake & Wendy H. Wong, *The Politics of Networks: Interests, Power and Human Rights Norms*, in NETWORKED POLITICS: AGENCY, POWER, AND GOVERNANCE (Miles Kahler ed. 2009).

Zachary Elkins, *Constitutional Networks*, in NETWORKED POLITICS: AGENCY, POWER, AND GOVERNANCE (Miles Kahler ed. 2009).

Deborah Avant & Lindsay Heger, *The New Power Politics: Networks and Transnational Security Governance*, (2013).

Helen Yanacopulos, *Cutting the Diamond: Networking Economic Justice*, in NETWORKED POLITICS: AGENCY, POWER, AND GOVERNANCE (Miles Kahler ed. 2009).

Kathryn Sikkink, *The Power of Networks in International Politics*, in NETWORKED POLITICS: AGENCY, POWER, AND GOVERNANCE (Miles Kahler ed. 2009).

Costigan Thomas, et al., *The US Dollar as the Global Reserve Currency: Implications for US Hegemony*, 8 WORLD

REVIEW OF POLITICAL ECONOMY 104(2017).

Miles Kahler, *Networked Politics: Agency, Power, and Governance*, in NETWORKED POLITICS: AGENCY, POWER, AND GOVERNANCE (Miles Kahler ed. 2009).

Fabrizio Gilardi & Fabio Wasserfallen, *The Politics of Policy Diffusion*, 58 EUROPEAN JOURNAL OF POLITICAL RESEARCH 1245(2019).

George V. Hulme, *Soon, Quantum Computing Could Break Your Encryption*(2021), available at <https://securityboulevard.com/2021/01/soon-quantum-computing-could-break-your-encryption/>.

Roger Huang, *Here's Why Quantum Computing Will Not Break Cryptocurrencies*(2020), available at <https://www.forbes.com/sites/rogerhuang/2020/12/21/heres-why-quantum-computing-will-not-break-cryptocurrencies/?sh=69e3e60167b5>.

Xiaochuan Zhou, *Understanding China's Central Bank Digital Currency*(2020), available at http://www.cf40.com/en/news_detail/11481.html.

Reuters Staff, *Bank of Canada Says Global Approach Needed on Digital Currencies, Working With G7*(2020), available at <https://www.reuters.com/article/idUSKBN27D3AQ>.

Lael Brainard, *An Update on Digital Currencies*(2020), available at <https://www.federalreserve.gov/newsevents/speech/files/brainard20200813a.pdf>.

Mette Eilstrup-Sangiovanni, *Varieties of Cooperation: Government Networks in International Security*, in NETWORKED POLITICS: AGENCY, POWER, AND GOVERNANCE (Miles Kahler ed. 2009).

Qian Yao, *A Systematic Framework to Understand Central Bank Digital Currency*, 61 SCIENCE CHINA INFORMATION SCIENCES 1(2018).

Bank of England, *Central Bank Group to Assess Potential Cases for Central Bank Digital Currencies*(2020), available at <https://www.bankofengland.co.uk/-/media/boe/files/news/2020/january/central-bank-group-to-assess-potential-cases-for-central-bank-digital-currencies.pdf>.

Bank of Russia, *Central Bank Governors Discuss Pandemic's Effects and Digital Currencies Issues*(2020), available at <https://www.cbr.ru/eng/press/event/?id=8249>.

PHOEBUS L. ATHANASSIOU, *DIGITAL INNOVATION IN FINANCIAL SERVICES: LEGAL CHALLENGES AND REGULATORY POLICY ISSUES* (Kluwer Law International. 2018).

Binance Research (Jinze & Etienne), *First Look: China's Central Bank Digital Currency*, (2019).

Bank of Canada, *Contingency Planning for a Central Bank Digital Currency*(2020), available at <https://www.bankofcanada.ca/2020/02/contingency-planning-central-bank-digital-currency/>.

Karen Yeung, *What Is China's Cryptocurrency Alternative Sovereign Digital Currency and Why Is It Not Like Bitcoin?*(2020), available at <https://www.scmp.com/economy/china-economy/article/3083952/what-chinas-cryptocurrency-sovereign-digital-currency-and-why>.

Andrew Keane Woods, *Litigating Data Sovereignty*, 128 YALE LAW JOURNAL 328(2018).

Dirk A Zetsche, et al., *Decentralized Finance*, 6 JOURNAL OF FINANCIAL REGULATION 172(2020).

Boao Forum for Asia, *ZHOU Xiaochuan: Sino-Singapore Digital Currency Cooperation Could Start From Retail*(2020), available at https://mp.weixin.qq.com/s/7Gweq4oP_EwKviqR281Qbg.

Mark Carney, *The Growing Challenges for Monetary Policy in the Current International Monetary and Financial System*, *Speech Given by Mark Carney, Governor of the Bank of England*, (2019).

Samuel Haig, *JP Morgan: CBDC Threatens Hegemony of US Dollar*(2020), available at <https://cointelegraph.com/news/jp-morgan-cbdc-threatens-hegemony-of-us-dollar>.

Janice Gross Stein, *The Politics and Power of Networks: The Accountability of Humanitarian Organizations*, in NETWORKED POLITICS: AGENCY, POWER, AND GOVERNANCE (Miles Kahler ed. 2009).