Digital Money at the Water's Edge: The Global Political Economy of Central Bank Digital Currencies

by

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A dissertation submitted in partial satisfaction of the

requirements for the degree of

Doctor of Philosophy

in

Political Science

in the

Graduate Division

of the

University of California, Berkeley

Committee in charge:

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Professor Barry Eichengreen
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Spring 2022

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Abstract

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Currency is the fundamental economic technology that makes promises credible among actors within and across societies. From shells, to metals, to paper, the technology of money has continually evolved to meet the changing needs of human society. The 21st century is witnessing yet another evolution in the technology of money: digital currencies. Although political economy scholarship has begun to focus on digital currencies, this research has largely focused on single early examples like Bitcoin. In this dissertation, I offer a systematic initial analysis of how digital currencies intersect with traditional dynamics of global political economy. The first chapter explores the ecosystem of digital currencies and theoretically organizes different digital currencies along technical features that are relevant for domestic and global governance. The second chapter proposes a theory of strategic interaction in a particular class of digital money, central bank digital currencies (CBDCs), and identifies testable hypotheses premised in a theoretical framework of pressures associated with CBDCs that either align with or update prior government preferences. The third and fourth chapter respectively test hypotheses pertaining to theoretical expectations of CBDC project timing and design choices, demonstrating strong support for the proposed theory using a wide battery of statistical tests on novel empirical data produced in this dissertation project. The fifth chapter extrapolates trends from the third and fourth chapter, proposing a novel relational theory of first-mover advantage in CBDC projects premised on theories of policy diffusion and demonstrates support for these theoretical expectations with evidence from social network analysis on the datasets described in the preceding chapters. The sixth chapter concludes with a summary of insights, a set of policy prescriptions for decision-makers arising from this new knowledge, and lines for future research on this topic.

To my parents, who nurtured my creativity.
To my teachers, who fostered my curiosity.
To my friends, who always supported my joy.
To Ophelia, who held me together throughout.

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Acknowledgments

I am extremely grateful for careful feedback from my three committee members over the course of this research. To Vinnie Aggarwal, whose unwavering support was matched with a regular and incisive push toward theoretical, conceptual, and empirical development in this research. To Barry Eichengreen, whose keen eye toward both the global implications and the specific policy consequences of these results made this research realistic and grounded. To Heather Haveman, whose sharp eye for organizational power kept me focused on the areas where the real processes of consequence occur in the transition to digital money. I am also grateful for research assistance from Sophia Corrales and Fan Shi. Finally, I am also grateful for the significant research funding from the University Blockchain Research Initiative (UBRI) in financially supporting this project, and I am grateful for the MIT Digital Currency Initiative (DCI) in supporting and socializing this research.

Chapter 1

Bigger than Bitcoin

1.1 Introduction: From Cash to Code

Currency is the fundamental economic technology that makes promises credible among actors within and across societies. This has been the defining feature that unifies highly different types of currencies that have emerged through human history. Ranging from shells to various metals, and eventually to today's paper currencies, money has taken a wide variety of physical forms (Jenkins 2014).Each of these incarnations of money has evolved to meet changing human needs surrounding the core functions of currencies. In this respect, currencies are not only instruments which facilitate economic activity; currency is a technology of money that makes commitments between actors credible. As the technological capabilities of society evolve, and as the unique needs for insuring promises among actors change within and across societies, the technology of money also changes accordingly.

The 21^{st} century is witnessing another evolution in the technology of money: digital currencies. While Bitcoin remains the most well-known case of digital currencies disrupting traditional economic and political relations, it is far from the most significant advancement in this area. Indeed, digital currency development dates back over a decade prior to Bitcoin's launch and is premised in the same forces which have shaped the evolution of money over time: economic inefficiencies intersecting with political power structures. As I argue in greater length below, whereas much research approaches digital currencies as motivated strictly by economic inefficiencies, this evolution in the technology of money cannot be wholly understood without concurrent attention to both the pre-existing power relations among actors in economic arenas, and the implications of digital currency design choices for power relations among traditional and new actors in economies. In this respect, the study of money, technology, and disruption remains incomplete without scholarship by political economists which attends to the unique role of institutional power in mediating processes of technical and economic change within and across economies in the world.

While digital currencies constitute a familiar intersection of economics and politics, political economy scholarship has not yet rigorously engaged with the full ecosystem of digital currencies. Although this is due in part to the early focus on economic inefficiencies, I argue that the importance of power relations to digital currency development implicates political economy theory in this area. Further, I argue that political economy can better engage with this space with attention to three key variables of digital currency design that most directly affect power relations among actors they involve: value backing, supply mechanism, and ledger technology. In attending to these three key variables, I argue that political economy can begin to more systematically analyze the importance of digital currencies to power structures in economic relations. In this respect, I explore three key areas of research where digital currency developments most clearly intersect with existing political economy scholarship: corporate governance, banking regulation, and sanctions.

The chapter proceeds in the following sections. I first offer a brief review of other examples in the evolution of monetary technology to show the importance of both economic inefficiency and power relations in economic arenas as they guide the development of new forms of currencies. Here, inefficiencies refer to the limitations which a given technology of money imposes on that currency's ability to meet the theoretical roles of money, especially at scale. Drawing on this two-factor framework for understanding power in the evolution of money, I explore three crucial points of variation in digital currencies cited above, first by exploring the choices available in digital currency design and subsequently by discussing their importance to political economy in particular. These include the role of value backing, supply mechanisms, and ledger technology in differentiating different digital currencies and their externalities. I conclude the chapter with a proposed research agenda for the digital currencies in political economy, including the three key substantive issues above. In each sub-section, I discuss how digital currencies stand to affect power in economic relations and identify questions for future research to understand these developments.

1.2 Currency, Technology, and Power

Currencies, as the technology of money, have historically evolved to meet the changing needs of human society. In the process, the natural and intentional features of currencies that make promises credible in monetary relations have favored the preferences of some actors in society over others'. The history of money shows that these intersecting roles in economic efficiency and political power relations are a salient issue which influences both the design of currency and the social structures in which currencies are embedded. The historical record strongly suggests that currencies are not only instruments designed to make economic relations more efficient, but also that the technological design of currencies is a focal point for power struggles within and across economies. Simply, the intersection of money and power cannot be understood without attention to how they have each co-evolved with the *technology* of money, in the form of different currencies, over time.

On one hand, we have seen the technology of money evolve to address chronic social issues which make promises either less credible than are demanded among economic actors, or issues which make such credibility more costly. A first and obvious example here is the general consensus among historians that money evolved in the form of currencies to correct the inefficiencies of markets which relied on barter for exchange in each transaction (Jenkins 2014), an inefficient and easily manipulated system of economic exchange. While this almost-too-common example makes clear the value of money in ensuring credibility of market prices, it fails to capture the ways in which currencies have evolved as technology of money since then to better insure promises among actors in society, due in no small part to its role as a functional origin story for currency more generally. As such, we may consider more recent examples of how the technology of money has evolved to address chronic social, political, and economic inefficiencies of previous currencies to examine the unique roles of inefficiencies and power relations in the process of technical change and social disruption.

One salient example is early cases of government coins, which were motivated in part to address the inefficiencies of private market currencies that flourished in unconsolidated monetary economies. An especially interesting example can be found in the transition from commodity currencies, to precious metals, and eventually to government coins in the early colonial United States economy (Burn 1936; Russell 1991). Another example is the transition from metal coins to paper "IOU's" among governments and economic actors. These arose in China to address inefficiencies in the greater scarcity of currency metals than the desired scarcity of currency (Pickering 1844), and in the West to manage the liquidity squeezes of trans-Atlantic trade as this became the primary business for mercantilists (Goldberg 2014). In each of these cases, new technologies of money have been either naturally or intentionally designed improvements on the inefficiency of preceding currencies, and have in each case transitioned to a design which better insures promises among actors in and across economies.

On the other hand, the technology of money does not evolve in a vacuum. Rather, as the needs of society evolve to demand different physical forms of money, these decisions around updating the design of currencies have historically been nested in social power structures within and across the confines of sovereign borders. As such, power asymmetries within and across societies have an undeniable influence over new monetary designs. In this case, we see clear interlinkages through history between power and currency design which suggest a need for attention not only to social, political, and economic inefficiencies that create demand for change, but also the various power structures that shape this change in currencies.

One early example here can be found in pre-independence India, where cowrie shells served most, if not all major functions of money in the economy (Yang 2011). The use of these shells as an instrument of credible money dates back to the Neolithic era per archaeological records (Perlin 1983), and lasted well into the slave trades of more recent human history (Hogendorn and Johnson 2003). However, the East India Trading Company began systematically rejecting the use of cowrie currencies for official trade and taxation under direction of the British Crown. This is cited as a major cause of the Patnaik Rebellion in 1817 India, which was the first armed movement in Indian independence (Tanabe 2020). More recently, we see power structures intersect with changes to the technology of money, as in the case of credit cards, whose role in the United States was not only a hard-won result of lobbying by the financial sector (Stango 2003; Simkovic 2009), but which has also slowly transitioned the authority of money supply from governments and to private actors.

Indeed, history has not yet ended for the co-evolution of power and currencies. In line with the above examples, the advent of digital currencies stands as a familiar dynamic of evolving monetary technology. In this respect, we cannot understand the politics of today's digital currency revolution without attention to the two factors outlined above: technology addressing inefficiency, and power structures shaping how these issues are addressed in currency design. However, while I argue that the digital currency revolution can be understood through a similar framework of evolution in the technology of money, digital currencies inhabit a unique context on the global stage which implies a unique set of causal factors driving this process. Specifically, we cannot understand the core technical feature which triggered the digital currency revolution – blockchain – without attention to the chronic economic and political tensions its application in cryptocurrency sought to address. Similarly, we cannot understand the design of digital currencies or their economic implications without attention to the power struggles emerging around different kinds of digital currencies.

There is a rich history of work toward digital currencies in decades before 2008 which serves as necessary antecedent to political economy scholarship on this topic, and which lays bare the longer history of economic inefficiencies that digital currency efforts sought to address in society (Brunton 2019). As early as 1983, 'blind signature' payments were being developed to address chronic economic issues like limited auditing capabilities among governments (Chaum 1983). By 1996, legal scholars had worked to outline the contours of an 'anonymous electronic cash' (Law, Sabett, and Solinas 1996), and computer scientists worked to find security issues associated with these systems, in efforts to make peer-to-peer and large-scale transactions more efficient than traditional payments (Asokan et al. 1997). However, these early technical designs all worked from a common assumption of a central intermediary like a traditional retail or central bank. The technical implications of centrally coordinating and validating electronic transactions at scale posed too large an issue for these proposals to be realized (Tschorsch and Scheuermann 2016).

The emergence of Bitcoin and other cryptocurrencies is better understood in this historical context. Bitcoin's pointed proposal to build an economic world without intermediaries, especially central banks (Nakamoto 2008), was not only a social reaction to the global financial crisis but was also its key technical promise in overcoming previous obstacles to digital cash. In this way, Bitcoin's white paper served as a proof-of-concept for the potential of decentralized digital currency and leveraged a moment of popular discontent with centralized monetary authority to gain traction. Here we see early support for the two-factor framework around the technology of money applied to digital currency development: the intersection of a breakdown in social structures which triggered a widespread economic crisis, and the application of expert knowledge - blockchain - to disrupt those prior power structures.

However, in leveraging this political context to gain salience as the first actualized cryptocurrency, Bitcoin functionally created a market space for digital currencies. This space was rapidly populated by hundreds of 'altcoins,' or alternative cryptocurrencies, in the years after Bitcoin's launch (Halaburda and Gandal 2016). While virtually all of these altcoins retained the decentralized approach of Bitcoin, they varied widely in their application of blockchain technology – and in many cases explicitly altered the logic of how this technology ensured the security of the currency network – in order to achieve different social and economic goals through these digital currency projects. This is due to the fact that blockchain technology is not specific to digital currencies; rather it is a multi-sectoral application of expert knowledge which can be applied to a wide array of social and economic relations to render those relations more efficient (Foroglou and Tsilidou 2015; Gabison 2016; Miraz and Ali 2018; Pilkington 2016). Conversely, and as explored in more detail below, digital currencies are multi-technological and multi-platformed instruments, implying a dynamic and only partial intersection between these currencies and blockchain technology (R. Auer and Böhme 2020; Campbell-Verduyn 2017; Sapovadia 2018; Tschorsch and Scheuermann 2016).

Early research in political science and economics which has explored the cryptocurrency space beyond Bitcoin demonstrates clearly that the design of these alternative digital currencies is affected by power structures in how they address economic inefficiencies. Across the ecosystem of altcoins, we see clear relationships between technical design and efficiency improvements within the digital currency economy, especially in the different variations on blockchain consensus protocols such as proof of work or stake, or in newer developments like layer 2 protocols to improve efficiency of existing blockchain networks (Ethereum 2021; Sriman, Kumar, and Shamili 2021). As explored in important early social science research on the cryptocurrency ecosystem, though, there are explicit relationships between power structures and the design of these alternative digital currencies over time. Here, we see linkages with traditional issues in political economy, ranging from the role of digital currencies in international money laundering efforts (Campbell-Verduyn and Goguen 2017), to broadening global financial inclusion (Rodima-Taylor and Grimes 2017). Notably, much of this work highlights the ways in which variation along digital currency design produces different intrinsic governance capabilities or regulatory demands (Hsieh, Vergne, and S. Wang 2017).

These developments extend far beyond the case of decentralized digital currencies like Bitcoin. Not long after the rise of early cryptocurrencies, companies across the world began accepting Bitcoin and other cryptocurrencies for transactions (Hargreaves 2013; Pagliery 2014; A. Smith 2014), which raised the profile of these instruments as they became further integrated in the global economy. However, other firms strategically coopted the technical logic of cryptocurrencies like Bitcoin to build a new type of instrument: initial coin offerings (ICOs). These digital currencies, often built on the blockchain of another cryptocurrency like Ethereum, allow a firm to offer digital coins in lieu of stocks to raise money. Most often, these do not offer ownership in the firm, and rather allow buyers to profit from the firm's success and use those coins for products or services (Fisch 2019). Quite often, these ICOs were more centrally managed by an issuing firm, acting more as 'tokens' than the designs found among Bitcoin and altcoins. Furthermore, ICOs are designed to be pinned to firm value, unlike the value of Bitcoin and altcoins, which is a function of blockchain consensus. In these features of ICOs, which are technically distinct from cryptocurrencies, we see an efficiency gain in scaling blockchain ledgers for programmable private money, and the effects of prior power structures in the form of firms subverting existing regulations around corporate fundraising.

Importantly, we have also seen the relationship between efficiency as demand for, and power shaping supply of digital currency technology in the realm of fiat currencies as well.

First, firms in the private digital currency sector produced a new class of instruments called 'stablecoins,' which, by design, maintain a stable price relationship to specific targets, like gold or the US dollar (Lyons and Viswanath-Natraj 2020). Unlike Bitcoin, which has an algorithmically-limited total supply of digital tokens over time, these instruments maintained value through dynamic supply algorithms, or actual asset holdings by firms (Dell'Erba 2019). Building on the stability that stablecoins offered, individuals and firms further began creating a richer market environment for digital currency transactions based on blockchains, known today as 'decentralized finance' (Chen 2019) Here, the relationship between efficiency gains and power structures may be most explicit. Stablecoins and decentralized finance respectively serve as efficient substitutes for fiat currency and traditional financial markets. Indeed, there is evidence that governments' warnings and bans around these instruments have been not only reactions to (Helms 2020; Xie 2019), but also drivers of innovation in newer implementations of those technologies (G. Aggarwal et al. 2019; Cheng and Yen 2020).

Perhaps most importantly, regulators have also played an active role in shaping the digital currency ecosystem beyond their voiced concerns for early versions of this technology. Most saliently, central banks across the world are fielding pilots into sovereign digital currencies, better known as central bank digital currencies (CBDCs). While China's pilot is among the best-known initiatives, recent surveys by the Bank for International Settlements suggest that well over 70% of responding central banks are actively engaged with research on their own CBDC (Barontini and Holden 2019), and that this number has grown significantly in the last two years (Boar, Holden, and Wadsworth 2020). This development has raised a litany of theoretical and practical questions, such as how CBDCs would intersect with traditional fiat currency and the infamous monetary policy trilemma (Bjerg 2017), the impact CBDCs would have on private banks and other firms (Andolfatto 2018), and the myriad considerations of CBDC design that shape these outcomes (R. Auer and Böhme 2020).

However, there is again evidence here for the framework of monetary technology identified throughout this section. While governments are on one hand reacting to significant inefficiencies like financial exclusion and declining cash usage, they are also actively motivated both by the substitutionary effects of other digital currencies against fiat, and in pursuing opportunities to shape global power by subverting sanctions, for example (Jazeera 2018; Rosales 2019). Many of these countries are already relying on cryptocurrency blockchains to subvert sanctions while developing CBDC projects to achieve this goal more effectively.

Broadly, across decentralized, private actor, and government produced digital currencies, we see an important combination of factors linking monetary technology to political economy. Whereas the design of monetary technology in digital currencies can be understood in part as a classic example of technology addressing inefficiencies in economic relations, this approach is alone insufficient to understand the evolution of digital currencies over time. Rather, to understand the emergence of different kinds of digital currencies and why they vary so significantly in designs, we must also observe the power structures which both drive and are affected by changes to this technology of money. With this conceptual framework, it becomes possible to more deeply study the ways in which digital currencies both disrupt and are shaped by phenomena of interest to our field, with examples like corporate governance, banks and payments, and government sanctions. However, to do so, we must first identify and organize features of digital currencies which are most implicated in power relationships in with domains where these instruments are designed.

1.3 Political Dimensions of Digital Currency Design

Diversity among digital currencies offers analytical leverage for research, but only if this diversity can be meaningfully organized. A proper dissection of digital currencies unveils arguably hundreds of ways in which they may be categorically distinguished, largely along technical features like algorithmic design and hardware demands. However, I argue that there are three design features which matter most directly for political economists: value backing, supply mechanism, and ledger technology. These each shape how technology of digital currencies makes promises credible among actors by introducing variation in the commodification or centralization of claims that give digital currencies value, the agency or automation behind supply, and authority structures imbued by digital ledger systems.

In this section, I briefly detail the observable variation in each of these dimensions of digital currency design with attention to the different instantiations of digital currencies today. I explore not only the different outcomes exhibited digital currency design across each of these three dimensions, but I also discuss how these each intersect meaningfully with power relations that are salient to the study of political economy. The section concludes with a table summarizing these three political dimensions of digital currency design, the variation in possible values across each, implications for political economy, and non-exhaustive lists of select examples of digital currencies which exhibit outcomes across each dimension.

i. Value Backing

What is the real value in a digital currency? For political economists, this remains a critical dimension in studying the newest incarnation of monetary technology given the roles that digital currencies have taken in economic relations. The answer to this question based on common narratives of digital currencies remains unsatisfying: that market value is in most cases a speculative bubble. However, while this may be true for Bitcoin, observers have noted that this is due more to the idiosyncrasy of its near-certain supply, which has left it to operate more as a risk-on commodity like copper or gold than a proper currency (Gronwald 2019). Notably, this is not the only model of digital currency value backing.

Functionally, there are two ways in which digital currencies produce value. The first, a more traditional logic of value backing, is claim-based; some digital currencies are backed by specific volumes of assets, fiat currencies, or in some cases, other digital currencies. Stablecoins serve as a helpful example of claim-based digital currencies. These are explicitly designed to maintain a fixed value against another economic object, such as the US dollar with Tether, and achieve this most often by holding the target asset for claims made against the stablecoin (Dell'Erba 2019). Other examples include digital currencies backed with gold;

Digix, for example, maintains a one-token value pinned to gold, which is held in a secure vault in Singapore and can be redeemed for the digital currency (Exchange 2019). Claim-based digital currencies incur traditional social and legal vulnerabilities of other claim-based instruments; for example, this leaves room for speculative attacks on a claim-based digital currency like those made against currencies with pegged exchange rates (Eichengreen 2018).

The second type of value backing among digital currencies is object-based, where the value of a digital currency comes from the value of its use, rather than by a claim to another instrument. Bitcoin proponents argue that it is more durable, secure, and predictable in supply than other stores of value like gold or fiat (Frisby 2014). Furthermore, Bitcoin enjoys a unique following that has buoyed its speculative value in traditional and cryptocurrency markets; it is this dimension which typically leads on-lookers to label it a market bubble (Cheah and Fry 2015). However, there are many other cases of object-based digital currency value beyond Bitcoin. Some digital currencies build value on the privacy of their transactions; these are often called 'privacy coins' and are known for relying on zero-knowledge proof encryption (Harvey and Branco-Illodo 2020). Other object-based digital currencies derive value from services that operate on their blockchains. Golem, for example, facilitates shared rental of computing power across token holders, producing value in the tokens that reflects the value of access to Golem's network (*Golem* 2020).

Currencies' value mechanisms have direct implications for both economic and political outcomes. Economically, we see familiar relationships between differences in value backing and capacity for market manipulation. On one hand, claim-based digital currencies recreate traditional tensions associated with pegged fiat currencies. Specifically, not unlike George Soros' 1992 attack on the British pound, the peg of a digital currency price to some asset allows for speculative short-selling which can distort digital currency markets and incur losses among issuers and holders. A similar attack occurred as recently as 2018 on a US-dollar-backed stablecoin, Tether, through large-volume sales of the stablecoin for Bitcoin (He 2018). Conversely, object-based cryptocurrencies both affect and are affected by regulations and markets around their price links. For example, privacy coins build cryptocurrency value through subversion of regulatory oversight, which challenges financial agencies to broaden enforcement to this domain (Haig 2020). The economic implications of differences in digital currency value backing recreate familiar power struggles in economic activity.

In each of these cases, the economic byproducts of differences in digital currency value backing opens unique vectors of constraint and opportunity to economic actors, whose engagement with digital currencies pressures regulators to oversee and manage those byproducts. These distinct sets of political and economic byproducts help to explain the trajectory of governance around claim- and object-based digital currencies. Whereas the clear fit for claim-based digital currencies have found a natural home in the banking sector, and thus fallen in bank regulators' domain (Post 2020), object-based digital currencies have naturally proliferated in corporate fundraising, subject to securities law (Peirce 2020). Perhaps most importantly, we see the edge of sovereignty already creating issues in value backing decisions among states. While all central bank digital currency projects involve some logic of claim-based currency, even here we see initial tensions regarding the nature of claims, such as the design of architectures that facilitate either familiar two-tiered structures of claims against retail and central banks, versus more radical hybrid and direct claim architectures which would substantially disrupt the intermediary power of banks (R. Auer and Böhme 2020).

ii. Supply Mechanism

A second dimension of digital currency design which is important to political economy is the mechanism by which supply is managed. Fiat currency has functionally one supply mechanism; sovereign governments issue or destroy money in an economy through adjustment, which affects both confidence and liquidity of the currency. Some digital currencies exhibit this supply logic as well, as with many tokens or ICOs. In these cases, new units of digital currencies are 'issued,' often through a smart contract on a blockchain network (Fenu et al. 2018). In other cases, units of digital currencies are considered 'pre-mined,' as with Ripple (XRP); issuance in these cases is a function of supply control, wherein the firm behind the cryptocurrency either buys or sells units to manage supply in circulation (Jani 2018). These issuance process mimic the traditional logic of fiat monetary issuance and introduces similar governance issues. This design feature often yields digital currencies with stable pricing, but notably introduces vulnerabilities associated with centralized authority. Ripple (XRP), for example, is explicitly designed to offer rapid and low-cost cross-border transfers; it is this important that the company which manages the cryptocurrency can strategically adjust the supply of this token in circulation in order to maintain parity for transfers.

Other digital currencies have algorithmic supply mechanisms. Unlike issuance, which relies on a central actor to oversee digital currency issuance, algorithmic supply is often a feature the protocol by which a digital currency's blockchain is maintained. In some cases, the algorithm underlying a digital currency's blockchain has a predictable rate of supply for the digital currency over time; Bitcoin, for example, has a total fixed supply of 21 million coins to be reached by approximately the year 2140 (Yermack 2015). Digital currencies with an algorithmically-managed supply exhibit different patterns of use than those with manually managed supply. For example, these kinds of digital currencies do not have the advantage of supply adjustment to target prices; this means that their market value is significantly more sensitive to speculation. This helps to explain why some digital currencies with this feature are subject to volatile price swings and do not function well as a store of value. However, this also means that these digital currencies become useful instruments for trades in other digital currencies, as their supply against counterpart currencies is easily predicted.

Political economists are very familiar with the power struggles that arise over currency supply issues. Indeed, the infamous trilemma of monetary policy implicates currency supply in other issues around exchange rate volatility and capital flows (Mundell 1963), a policy issue which continues to plague political economic decisions today (Aizenman 2010), and remains a central focus of scholarship on the politics of currencies. Here, we see a clear credibility issue associated with supply issuance that is reminiscent of much older concerns, from hyperinflation of the post-WWII era (Jacobs 1977), to new critiques of modern monetary theory (Mankiw 2020). The tradeoff between issuance and algorithmic supply mechanisms in digital currencies can be understood as a traditional concern around the credibility of currency supply and the choice between flexibility in price management, versus the credibility of tying one's hands. While we need look no further than scholarship around the Bretton Woods system to understand how this design choice was managed in fiat currency (Eichengreen 1993), today's digital currencies involve much more diverse actors and instruments.

Digital currencies' supply mechanisms directly affect their function as economic instruments, by constraining or empowering different strategies among actors with power over circulation. This has implications both for the inflationary or disinflationary tendencies of a digital currency, as a function of whether adjustment can occur and, if so, whether that can be centrally coordinated or emerges from patterns of exchange. In the classic case of Bitcoin's algorithmic supply, we see the digital currency creating strong competition with traditional assets which share this feature, like gold (Shahzad et al. 2019).

Conversely, we see supply issuance creating significant issues for organizations which create digital currencies, like the Ripple corporation XRP. As the organization is able to manage the supply of these tokens and operates as a legally registered company, the choices around issuing and destroying those tokens creates important intersections with securities laws, a tension which recently brough Ripple into a legal dispute with the US Securities and Exchange Commission (SEC) (Martin 2021). As such, the credibility effects arising from digital currency supply mechanisms directly implicate digital currencies in traditional political economy issues around asset classes, intermediaries, and regulations.

iii. Ledger Technology

Digital currencies rely on a virtual ledger of all transactions to verify the number of units in circulation and validate transitions of ownership. This is sometimes a particular class of digital ledger, a blockchain, which encrypts transaction data in a decentralized manner. While not all digital currencies operate on blockchain, many decentralized versions of those instruments rely on this mode of ledger encryption to remove trust from the equation of economic transactions; this was one of Bitcoin's central technical promises cited earlier (Nakamoto 2008). Here, a key difference among digital currencies' digital ledgers is whether they are publicly or privately accessed by individuals and firms using the currency.

Public ledgers are permissionless; anyone can join the network, making it both more transparent and less private. In turn, the computational demands of a public ledger are high, given the number of participants and decentralized responsibility for ledger management (O'Dwyer and Malone 2014). Bitcoin is an example of a digital currency with a public ledger, as is Ethereum, which is one explanation for their rapid adoption uptake as there are no barriers to entry. However, this design comes with a number of costs and byproducts. A primary effect is the increased likelihood of technical failure, known as 'forks' in the ledger, wherein a single blockchain ledger splits into several distinct branches (Trump et al. 2018). This has happened on the Bitcoin ledger due to miners' incentives to break the consensus structure of mining protocols (Biais et al. 2019). Because public ledgers rely on many end-users to validate transactions, their vulnerabilities are also decentralized. While this affords a number of instrumental benefits, such as scaling a digital currency across borders without significant and often difficult centralized coordination, it also creates large-scale collective action problems among actors on the ledger which can be difficult to centrally address.

Private ledgers restrict access to a set of pre-approved participants. Where consensus is achieved on public ledgers through decentralized transaction validation, private ledgers rely more often on 'leader-based consensus,' where network leader has authority to approve edits on the blockchain (Zhang and Jacobsen 2018). As a result, private ledgers require trust among network users and serve distinct purposes to public ledgers. Though private ledgers are more immune to collective action problems associated with public ledgers, these private alternatives imbue a greater hierarchy of authority on a blockchain and, by extension, create risk asymmetries. In these cases, blockchain vulnerabilities are more centralized in a specific node or set of nodes on the network, creating a clear target for attacks on a digital currency. Furthermore, because of the centralized computing demands of private ledgers, these digital currencies are more frequently operated by organizations or firms, as in the case of ZCash, a privacy coin which pitches itself as a 'privacy-protecting' alternative to Bitcoin.

The design of ledger technology implicates digital currencies again in familiar issues of political economy; in this case, ledger technology raises concerns around whether a digital currency's network is a public or private good. The issue of governing public and private goods has a long history in political economy scholarship (V. K. Aggarwal and Dupont 1999), and differences in this feature of currencies matters significantly for digital currencies' disruptive potential and related regulatory outcomes. Whether a digital currency ledger is public or private has clear implications for its role in economic relations and reception by regulators. The public or private design of a digital currency dictates the location of collective action problems associated with technical management and regulatory oversight. In public ledgers, responsibility for technical management is dispersed among a large number of end-users, producing unique emergent governance processes (Parkin 2019). Conversely, private ledgers have a more centralized responsibility structure; this skews the cost of management and centers it disproportionately on one organization or set of actors.

This difference helps to explain distinct patterns of regulatory response to digital currencies. Public ledgers have a larger number of actors to oversee, yielding blunt bans and warnings given the absence of a centralized target of regulatory response, whereas private ledgers can see specific governance responses given responsibility centralization. The difference in ledger technology can also be understood as a strategic decision based in power structures, rather than only as a mediator in the expression of power over digital currencies. Here we see the infamous choice of public ledgers for Bitcoin as part and parcel of the initiative to disintermediate money and finance (Nakamoto 2008), where we see traditional actors in the financial sector leveraging private ledger technologies to facilitate their own technological improvements as a counterforce against these rising challenges (Son 2019). Again, we see evidence that the choices in digital currency ledger technology are both byproducts of power structures, and also causes of change in power structures around these currencies.

iv. Summary of Political Design Features

In this section, I have argued that three design features of digital currencies create salient points of political tension: value backing, supply mechanisms, and ledger technology. In each case, I argue that while the technical dimensions of their variation in digital currencies may be substantively new, the political struggles surrounding those design features introduce political and economic issues familiar to scholars of political economy.

Table 1.1: Summary of Political Design Features in Digital Currencies

Features	***Values***	***Byproducts***	***Select Examples***
Value Backing	Claim Based	- Asset holding sensitivities - Speculative attacks	Tether (Dollar) Digix (Gold)
	Object Based	- Subvert existing regulations - Market competition in services, goods as value links	Privacy coins Utility tokens
Supply Mechanism	Algorithmic	- Demand sensitivity - (Dis)inflationary pressures	Bitcoin
	Issuance	- Adjustment pressures - Confidence speculation	Ripple
Ledger Technology	Public	- Energy, computing demand - Ledger forks, failure	Ethereum
	Private	- Participation authority - Costs to entry, private goods	Corda

By extension, I argue that these features of digital currencies will and arguably should be a central focus in future scholarship that addresses the political economy of digital currencies across different sectors and countries. In table 1, I briefly summarize these three design features of digital currencies, including the possible values realized in each design feature, the byproducts associated with design features, and selected examples of digital currencies which exhibit that design feature. While the byproducts and digital currencies are here illustrative examples for each design feature, they are by no means exhaustive lists, nor the only points of difference among digital currencies which exist today.

1.4 Toward A Political Economy of Digital Money

In the preceding sections, I have argued that currency, as a technology of money, has a long history of technical evolution which is driven both by economic and political considerations. In line with earlier examples like shells, metals, and paper money, today's transition to digital currencies at decentralized, private, and government levels constitutes a new iteration in how the technology of money has evolved. While the framework for understanding today's evolution of money can be drawn from earlier examples, I argue that we cannot understand the politics of digital currencies today without attention to three unique features of digital currencies which are imbued in power relations: value backing, supply mechanisms, and ledger technology. I have argued that choices in these features of digital currencies are not only made to improve economic efficiency, but are also influenced by prior power structures and have implications for power in the future digital economy.

A concluding byproduct of this framework and typology of political design features in digital currencies is the need for a research agenda in the political economy of these instruments. In this section, I briefly explore three areas of research which matter to political economists in the domain of digital currencies. These include: firms and corporate governance, banks and financial markets, and governments and international sanctions. In each of these concluding sub-sections, I detail existing areas of political economy scholarship whose theoretical explanations of power relations in each of these economic arenas is affected by design features of new digital currencies. I lay out the ways in which these existing approaches are challenged by the advent of new digital currency designs, and the avenues of future research necessary to improve political economy scholarship in these areas with explicit attention to the efficiency and power dynamics of digital currency design.

i. Firms, Corporate Governance, & Supply Mechanisms

Firms vary in the logic behind their profit maximization efforts, and by extension, firms allocate resources differently in accordance with these priorities. The power relations which produce and accompany these incentive structures are a key component of a rich line of scholarship on the issue of corporate governance in political economy. This line of research, initially preoccupied with comparative assessments of cross-national patterns in corporate governance, has more recently turned to study the varying ways in which firms produce value for their respective share- and stakeholders in the economy (O'Sullivan 2003). Importantly, we see attention to the dynamics of decision-making within firms that creates variation in profit-seeking behavior, investment, and both market and non-market strategies (Bebchuk and Weisbach 2010; Garvey and Swan 1994; Pagano and Volpin 2005). In these primary issue areas of corporate governance research, advances in digital currencies have direct implications for political economy scholarship on this topic.

Specifically, we see digital currency technology shifting dynamics of capital allocation among traditional firms. While salient news stories might direct attention on this issue to the question of specific companies, like Tesla, buying Bitcoin with their reserves (Hobbs 2021), this dynamic raises a broader question about corporate finance, investment, and shareholder value. Namely: how does the advent of private digital currencies that operate as assets change investment decisions among traditional firms? Here, we see the supply mechanisms of some decentralized digital technologies, like Bitcoin, guiding decisions as a function of deflationary price effects from algorithmically limited supply. Furthermore, this is not a strictly instrumental consideration of how algorithmic supply mechanisms shift firm incentives; we also see digital currencies with issued supply, like Ripple, attracting investment attention from traditional firms for the applications that this supply mechanism produces alongside differences in value backing and ledger technology (C. Kim 2021).

This disruption via change to value backing has created an important shift in how firms raise capital. Beyond the immediate topic of regulatory challenges associated with firm investments in private and decentralized digital currencies, there remain a wide array of questions for scholars of corporate governance. What are the firm and market level dynamics shaping the choice to invest in digital currencies – and how firms select different digital currencies to invest in – and what regulatory landscapes favor or disadvantage either strategy in this new context? How do traditional drivers of corporate financial decisions – such as board composition – affect dynamics around investing in different digital currencies? Broadly, the advent of new corporate financing opportunities which leverage a change in supply mechanisms among digital currencies pose interesting new questions for political economy research on corporate governance and finance.

ii. Banks, Financial Payments, & Value Backing

Banks have preferences for stable currencies and both economic and regulatory infrastructure that permits near-real time payments, limiting pairwise value fluctuations in transactions. In political economy, there is a long line of scholarship on how banks have not only worked to secure these conditions through their own private governance initiatives, but also extensive evidence on the myriad ways in which banks leverage social connections (Chalmers and K. L. Young 2020; Yackee 2019; K. L. Young, Marple, and Heilman 2017), market clout (Barth, Prabha, and Swagel 2012; Kaufman 2014; Moosa 2010) and their international positioning (Broz 2015; K. L. Young 2012), to extract desirable regulatory outcomes. Today's transition to digital currencies raises these issues, and regulatory advocacy has already begun.

Here, we see stablecoins playing a growing role among banks and financial markets. As discussed earlier, stablecoins provide an important change in banking relations due largely to their role in real-time payment settlement, a critical component of financial markets. Indeed, there is already a burgeoning literature on the economic mechanics which make these instruments technological improvements upon private versions of fiat money (Lyons and Viswanath-Natraj 2020). However, there is not yet research on banks' preferences for stablecoin design and regulation. This stands in stark contrast with the already-unfolding regulatory infrastructure for stablecoins, with salient news events like the US Office of the Comptroller of the Currency (OCC) allowing banks to use stablecoins in payment activities (Numeris 2021). Perhaps more important are the current deliberations at the IMF's Financial Stability Board (FSB) regarding an international regime for stablecoin definitions and rules, which are open for comment by private actors; a large majority of comments have come in from private banks across the world already (Board 2020).

In this respect, political economy faces a rich diversity of regulatory issues around stablecoins. Here, we again see political design features of these digital currencies playing an important role in the unfolding political conflict and still unresolved regulatory responses. In this case, stablecoins leverage a combination of new value backing – often in the form of algorithmically balanced prices – and ledger technology to improve on the previous technology of payment instruments. These design features are not only means to improve efficiency of payment technology, but also stand a potential challenges to the privileges enjoyed by banking intermediaries. Why do some banks support stablecoin legalization while others do not, and what explains differences in preferences for more or less controlling stablecoin regulation? How do new financial actors achieve their own interests in the regulation of stablecoins, and how does technical expertise in digital currencies affect – if at all – traditional processes of bank lobbying and private governance? In what ways are stablecoins liable to change structural patterns in domestic and global financial power, and how are these outcomes mediated by regulatory responses within and across states? These questions fall squarely in the purview of political economy and stand as important lines of future research.

iii. Governments, International Sanctions, & Ledger Technology

Governments derive extraordinary levels of non-violent power through the strategic use and regulation of their respective fiat currencies (Cohen 2018b; Kirshner 1997; Strange 1971). The primary mechanism by which governments exercise economic power to achieve geopolitical goals today is through sanctions. While the public-facing mechanism of sanctions is the simple declaration that a country, or group of people within a country, may no longer engage in the same economic activity as they previously could, the underlying mechanism of sanctions is directly related to the design of government money. Specifically, especially in the case of today's targeted financial sanctions (Drezner 2015; Eyler 2007), these exercises of power operate through a large global network called the Society for Worldwide Interbank Financial Telecommunications (SWIFT). This network operates as a functional 'blacklist' in sanctions by denying sanctioned actors participation in financial networks, and because SWIFT oversees a majority of global financial flows, this is an extremely effective instrument for countries seeking to achieve political goals through economic sanctions (Arnold 2016).

The effectiveness of sanctions is directly challenged by central bank digital currencies. This is not a strict challenge resulting explicitly from the transition to digital fiat currency, but rather a conditional challenge resulting from the possible design choices available in CBDC projects. Specifically, because CBDCs can be designed with either built-in or accompanying cross-border clearance mechanisms, those mechanisms can be designed in ways which render SWIFT obsolete (Kirkpatrick et al. 2019; Reynolds 2020). This is primarily due to the ways in which CBDCs vary from traditional government currencies, namely in programmable interoperability via permissioned digital ledger systems. Whereas today's digital ledger for global financial flows, SWIFT, privileges some countries over others as a function of asymmetrical control over a static ledger technology, new CBDC ledgers stand to decentralize this authority and undermine a critical tool for non-violent interstate power.

Why do some countries leverage this technological opportunity to challenge the sanctions status quo, whereas other countries with a history of being sanctioned are not? What are the implications of states' choices in pursuing more or less radical technical designs for CBDC ledgers and payment mechanisms for interstate alliances and economic relationships, and how do states' early choices affect the longer-term struggle over consensual global norms for technical interoperability? How might governments begin to coordinate to produce consensual standards for CBDCs and sanctions, and what form might this coordination take in a multilateral, regional, or bilateral manner? These, and other related questions in the domain of government money and sanctions power, stand as possibly the most significant disruption to traditional interstate relations resulting from digital currencies, and in this respect will be a central focus for scholars of sanctions enforcement as the population of countries pursuing these projects increases over time. This level of development is by far the most significant issue in the global economy today, and is the central focus of this dissertation.

1.5 Conclusion: Political Economy of Digital Money

Digital currencies are part of the long history in money's evolution, and as such are subject to the same driving forces of efficiency demands and power mediation as earlier currency revolutions. In this way, the design of digital currencies is both an important outcome associated with variation in today's economic inefficiencies and power asymmetries, and as a causal factor for understanding changes to economic governance in increasingly digital sectors. Three particular design characteristics of digital currencies matter especially to scholars of political economy, including the value backing, supply mechanism, and ledger technology across these new instruments. Specifically, these three features help to both organize variation in digital currency designs across a wide variety of decentralized, private, and government-issued instruments and serve as a starting point for studying digital currencies in political economy.

Although digital currencies constitute a wide-ranging variety of technologies, this chapter seeks to organize these new instruments for sake of scholarship in political economy. In this respect, neither the technical features explored in the typology nor the specific locations of economic activity identified in the proposed research agenda are exhaustive lists. Rather, this organizational effort is among the first installations in a political economy of digital currencies, a line of work which will necessarily proliferate as the tensions associated with money's evolution continue to expand into public and international arenas. Most importantly, this typology and proposed research agenda lays bare what is arguably the most critical line of developments in the evolution of money: central bank digital currencies.

As compared to decentralized and private developments, this shift toward CBDCs constitutes a radical rethinking of the most powerful form of money in the world, fiat currency issued by governments. As such, the typology proposed here serves not only as a springboard for future research on digital currencies more generally, but also situates the central focus of this dissertation on the specific case of CBDCs. The next chapter presents a novel theory of strategic interaction in digital government money, and is followed by empirical tests of the specific hypotheses which this theory implies. In line with the historical and typological argument set forth in this introductory chapter, the remainder of this dissertation explores developments in digital currencies which are much larger than Bitcoin.

The remainder of this dissertation proceeds in the following chapters. Chapter 2 develops a novel theory of global political economy in CBDCs, identifying domestic and international factors that either align with or update prior government preferences to shape strategic interaction in timing and design of these projects. Chapters 3 and 4 respectively offer primary tests of theoretical expectations around timing and design of CBDC projects. Chapter 5 extends upon chapters 3 and 4 with a novel theory and structural analysis of first-mover advantage in the propagation of CBDC designs across borders. Finally, chapter 6 concludes the dissertation with a summary of results, policy implications from the collected analyses, lines for future research in this general area, and likely future trends in the coming decade.

Chapter 2

Pushing Code and Pulling Neighbors

2.1 Introduction: Theorizing Politics & Money

Decades of research in international political economy affirms that government money is not only an economic instrument, but also a point of political friction between countries. This is due to the fact that money is a fundamental component of international politics. Money is an instrument for acquiring power, maintaining power, and exercising power over other states in the world (Cohen 2018b; Kirshner 1997). Importantly, while currency is a legal product of state sovereignty and governments have *de jure* control over their currency decisions, dense economic ties create political tension among states through the complex interactions among sovereign currencies (Cohen 2018c). In line with theories of strategic interaction among states (Keohane and Nye 2004), complex interdependence produces sensitivity and vulnerability in states' decisions around how to use and regulate money. This sensitivity and vulnerability creates inherently political problems around the domestic and international externalities of government choices regarding money. It thus stands as no surprise that research in political economy has affirmed: all money is politics (Kirshner 2003).

The politics of money include a broad array of actors and institutions within and across state borders. Existing research has elucidated the ways in which decisions about money are inherently political choices by state actors, with equally political implications. Key examples in this exhaustive line of work include the politics of central bank rates (Frieden 2016; H. Wang 2003), the political ramifications of monetary unions, such as the Euro (Marsh 2009; McNamara 1998), and most saliently, the domestic and international politics of choices around whether to internationalize a government currency (Seabrooke 2001; Strange 1971). This line of work has shown that the strategic politics produced by sensitivity and vulnerability among government currencies can shape the interests of a wide variety of actors, ranging from firms and banks, to consumers and voters, and to politicians and diplomats. In fact, there are few members of contemporary society who would not have a direct interest in the macroeconomic outcomes of strategic decisions around government money, with simple examples like its implications for inflation, employment, or returns on investment.

This research has raised the profile of money as a political object of interest, and international political economy no longer bears the burden of defending the intersection of global power and government money. Rather, the discipline has advanced significantly in this issue area and now engages with puzzles about what drives the politics of money, and the effects of these political struggles over money on interstate relations. For example, more recent work has explored how the simultaneous expansionary and tightening effects of globalization on domestic economies might produce an increasing concentration in the power held by select few currencies in the world (Cohen 2006). In other cases, recent research has explored how the US pursuit domestic and international policy goals through strategic use of its currency's reserve status may threaten the geopolitical status quo as the power of the dollar declines through other states' subversive responses (Helleiner and Kirshner 2012). As recent research in the global political economy of money has turned more to exploring the effects of political currency decisions on changes in states' power in the world, scholarship has begun to shine a light on some of the overlooked assumptions embedded in the field.

Notably, contemporary research on strategic politics of money rests on an assumption of static monetary technology. Most of this research has built and tested theories on the politics of decisions around government money which center on how a fixed instrument can be leveraged for political gains. This is due to the fact that research on money in international political economy scholarship is largely limited to the last 50 years (Cohen 2013), a time in which the technology of government money remained very much static. Arguably, the most recent major decision governments faced around the nature of money was shortly before the advent of this work, during the 1970's dissolution of the Bretton Woods system (Eichengreen 1993). This shift created true fiat currency, or a system of government money which was built on claims against government credit, rather than against government holdings of some precious metal or other reserve. Since that time, the nature of government money as a fiat claim has remained largely unchanged on the world stage.

In the context of static fiat monetary technology, countries have either enjoyed or suffered the status quo of what money is and what it does among countries. This status quo has been largely characterized by a dollar-denominated global economy, wherein the vast majority of trade and financial transactions are conducted in the United States' sovereign currency (Prasad 2015; Seabrooke 2001). Economically, this status quo has afforded stability for the rapid globalization witnessed over the last half century. Politically, this status quo has inordinately empowered some states – such as the United States in its 'exorbitant privilege', and the myriad advantages this affords US allies (Thornton 2013). By extension, this has subordinated other states via instrumentalization of money for political strategy (Kirshner 1997), with examples like strategic domestic policy, interstate sanctions, and norm enforcement. Given the costs and opportunities associated with today's global monetary regime, some countries would rationally prefer to maintain the current state of global monetary politics, and other countries would rationally prefer to change the status quo, to varying degrees.

Differences in states' preferences for maintaining or changing the status quo of monetary technology has not mattered in the absence of exit options, such as alternate models of monetary technology to adopt. In this respect, the assumption of static monetary technology in research on the global politics of money has been well-justified during the time of its authorship. However, it suggests a lacuna in the literature which more recently requires an answer: how to understand states' preferences and behaviors when deviation from the status quo of monetary technology is possible. As I discuss in the next section, improvements in computer technology have made possible a radical change to the technology of government money, and this change affords multiple option sets to governments. While the underlying logic of strategic interaction in money as a function of mutual sensitivity and vulnerability to governments' respective choices remains a sound framework through which to understand this dynamic, a theory of strategic politics with *dynamic* monetary technology requires attention to the specific technical choices facing states, and how this informs their preferences.

2.2 Politics of Dynamic Monetary Technology

Today, due to the advent of private digital currencies like cryptocurrencies and initial coin offerings discussed in the previous chapter, countries are facing and creating a challenge to the monetary status quo. The primary challenge comes in the form of government digital currency projects, such as those being researched across the world, and actively piloted in various countries (Boar, Holden, and Wadsworth 2020). While many governments already technically have digital money – the *M0* (wholesale) money supply has long been a strictly digital relationship between central banks and private banks – the current pivot toward digital currency holds potentially massive consequences. Namely, in building digital versions of fiat currency for use at scale, governments are revisiting central questions of what money is, and how money can be used by states in interactions among sovereign countries.

As the effects of governments' decisions around their own digital currencies affect other countries' choices through economic interdependence, questions about issuing and designing sovereign digital currencies are inherently political. By extension, the answers states offer to these political questions will be shaped by the opportunities and constraints associated with their different options and how these factor into domestic preferences and international pressures. The variation in whether, when, and how governments have chosen to pursue digital currencies in the last decade clarifies that this issue is being taken seriously by state actors. The expressed motivations of some projects, like China's, being to challenge the distribution of monetary power shows that this issue is not trivial (Ehrlich 2020). As such, salient questions remain for practitioners of international political economy about the political dimensions of sovereign digital currency. Specifically, why do governments choose to pursue digital money, and what explains the variation in the timing of their choices and progress in developing central bank digital currencies? And when governments do pursue digital money, why do their designs vary so substantially and what explains pairwise similarity in designs?

These questions can still be studied through a lens of strategic interaction under complex interdependence. However, while the mechanisms of domestic economic preferences and international pressures operate similarly in the context of new monetary technology, the causes of variation in outcomes are substantively unique to the nuances of new digital currency projects. While existing work on government digital currencies has focused almost exclusively on the domestic economic drivers of why governments pursue digital money, I argue that these questions cannot be answered without concurrent attention to the strategic politics among states, centered on the issue of economic and political interdependence and related mechanisms of sensitivity and vulnerability to other states' choices. By extension, I argue that government decisions about sovereign digital money necessarily include strategic economic and political considerations of the decisions made by other countries. As compared to the existing scholarship in political science and economics on the politics of static monetary technology, these projects raise important new questions about how sensitivity and interdependence shape state preferences and behaviors in changing the technology of money.

On one hand, the logic of strategic interaction over changes to the technology of money can be understood as an extension of the same mechanisms which make static monetary technology salient. Complex interdependence remains the mechanism by which states' choices around updating their currencies to a digital format affect other states' choices. As with decisions around how to use or govern static money, states face pressure from domestic constituencies and from international peers with regard to the consequences of their choices in whether, when, and how to update the technology of their money. States remain sensitive to how decisions around digital money might affect existing channels of economic and political relations with other states, and are politically and economically vulnerable to other states' decisions around revisiting the design of government money. In these respects, the basic framework of interstate relations in dynamic monetary technology remains similar to existing theories of strategic relations around money, as choices are shaped by similar forces.

On the other hand, strategic competition with dynamic technology of money involve new substance in the decisions states face and the consequences they have for domestic constituencies and international peers. Whereas traditional decisions in strategic relations around money include questions of how static currency might be used or weaponized to achieve economic or political goals, the advent of digital government currency has introduced a new menu of ways in which money can be reimagined and intentionally reshaped by strategic government actors. More simply, the actual policy choices available to governments in decisions around digital money are unprecedented, and qualitatively different than the policy choices around fixed technology of money. In this respect, the logic of strategic interaction resulting from sensitivity and vulnerability operates through distinct mechanisms which are unique to this decision juncture. Namely, the types of domestic and international pressures facing governments in digital currency decisions are a direct result of how new options in the technology of money interface with private and government actors' economic and political preferences, implying distinct processes of interstate strategic interaction.

There is one other salient instance of state decision-making around sovereign currency which captures this dynamic of change in the nature of fiat money – specifically, governments' decisions whether to internationalize their currencies. As with the contemporary evolution in the technology of government money, the decision by states around whether to internationalize their currencies has significant ramifications for a country's power in rewriting what its currency *is* and can *do* in international political and economic relations (Strange 1971).

This research is a critical example of strategic interaction among states on dynamic issues related to government money and in this respect provides a useful theoretical corrolary for understanding the contemporary analog to this issue. This literature dates back to early research on the political economy of money, serving as the seminal intersection between economic questions of government currency and political questions of power among countries, and provides some expectations for the role of unprecedented causal factors.

This line of research identifies domestic and international influences over states' decisions to internationalize a currency. On one hand, key domestic constituencies like banks and other liquidity-intensive industries have strong preferences around the domestic or international status of a currency, and express those preferences in ways which shape government decision-making (Germain and Schwartz 2014). In some cases, domestic constituencies share preferences with the state, which fosters consensual decisions around internationalizing a currency; in other cases, preferences differ in ways which either inhibit government decisions or diminish firms' economic performance and political power (Cohen 2012). However, research has also found that states also consider international factors in decisions about internationalizing their currencies. Here, these are primarily centered on the international ranking and use of a currency in economic exchange which produce power dynamics among countries via their respective economies (Andrews 2006; Strange 1971). Where some countries face international incentives to internationalize their currencies in status quo conditions, as in the case of internationalizing a currency to improve monetary power against other states, other countries change the status of their currency based on other states' choices in this domain (Cohen 2018b; Helleiner and Kirshner 2012; Kirshner 1997; McNamara 2008).

In this respect, there are both domestic and international factors influencing state decisions on dynamic questions of government money, and these vary in their alignment with or departure from prior government preferences. We can understand these as causes of variation in state decision-making which span two dimensions: (i) location of cause and (ii) alignment with pre-existing government preferences. While the location of these causes is either domestic or international, variation in the latter dimension requires conceptual organization. We can understand these as either *push* factors, which align with prior government preferences, or *pull* factors, which change government preferences within the decision space. An example of push factors is a pre-existing policy priority held by the state which aligns with monetary decisions, such as internationalizing a currency to improve export value in markets where a state engages in trade. Conversely, pull factors might include instances where one country's decision updates the preferences of another country. An example here might be internationalizing a currency in reaction to another comparable country's choice to do so, in order to avoid comparative disadvantages in currency standing resulting from the first country's choice. Pull factors are importantly different from push factors as they differentiate strict and weak preferences in strategic decisions on dynamic issues and offer theoretical expectations regarding issues of timing and substantive choices in strategic interaction.

This line of research serves as a starting point for my theory of variation in government digital currencies. The literature on when countries internationalize their currencies serves as the closest analog for the strategic politics of challenging what money is and what it can do in global affairs. As such, the framework of push and pull factors at the domestic and international levels offers a useful initial framework for the mechanics of causation in strategic interaction of government decisions that face dynamic questions around money. In line with research on decisions to internationalize a currency, I argue that governments pursue digital currencies in part as a function of pre-existing preferences (push factors) regarding domestic and international pressures. Further, I argue that states make digital money decisions as a response to shifts in the status quo at the domestic and international level, the latter of which being primarily (non-)choices made by other governments on digital money. Specifically, when governments do pursue digital currencies, I argue that domestic and international factors produce variation among states in the timing and substance of digital money decisions. Consequently, I also argue that states' choices in the timing of their digital currency affect choices on substantive design features in those projects. In the next section, I detail theoretically informed substantive push and pull factors which cause variation among states' decisions in the context of government digital money, and derive hypotheses around whether, when, and how governments choose to pursue digital currencies.

2.3 Causes of Variation in Digital Currency

This literature on interdependence and monetary decisions helps to characterize the broad classes of causes over state choices in digital money, and the substance of these expectations can be identified in the specific features of digital currency projects under consideration among states. Namely, existing theory in international political economy suggests attention both to domestic and international causes of variation in government decisions affecting dynamic technology of money and differentiating these causes along their alignment with (push factors) or difference from (pull factors) pre-existing government preferences.

Beyond push and pull factors, I also discuss what I call permissive factors, which shape the viability of digital currency projects independently of prior preference structures within a country or government. Given the technical specificity of digital government money, these permissive factors serve as important factors shaping the viability of digital currencies across countries. Below, I outline substantive causes of variation across these two dimensions and summarize these classes of substantive factors in table 1. In the final section, I derive hypotheses regarding how these factors cause variation in state decisions on digital money.

i. Domestic Causes of Variation in Digital Currencies

Some variation in digital currency projects can be explained by domestic push, pull, and permissive factors. In the context of understanding the interstate politics of digital currency timing, design, and coordination, we can understand these domestic factors as causes of different baseline preferences among governments. This is especially true given the interdependence between the primary domestic push and pull factors shaping digital currency decision-making: economic inefficiencies and cryptocurrency prevalence. On one hand, governments face existing issues in their domestic economies which span two extremes: (i) financial inclusion and underbanking, and (ii) declining cash use in retail transactions.

One extreme is the issue of under- and unbanked populations, a phenomenon by which individuals in a country cannot access traditional financial services like banks (Figart 2013). This creates economic and political tensions in a country as it often forces consumers to rely exclusively on cash in ways which affects the monetary policy options available to government decision-makers and which augment the domestic shadow economy. On the other extreme is the issue of declining cash use, which is more prevalent in developed Western economies that have widespread credit card adoption (Fung, Huynh, and Sabetti 2012). This extreme of economic inefficiency creates issues for government decision-makers in the form of diminished authority over the money supply, which is lost to private actors in the banking sector. Both of these inefficiencies constitute push factors facing governments, as they align with existing economic incentives and policy goals held by state actors in countries with those inefficiencies. We can understand both of these as a form of currency inefficiency driving state decisions.

These inefficiencies, however, are related to a consequential pull factor at the domestic level: cryptocurrency use within domestic economies. As a result of the tensions produced by underbanking and declining cash usage, cryptocurrencies have become attractive substitutes for government money in economies which face those particular economic inefficiencies (Fung, Huynh, and Sabetti 2012; Goodhart and M. Krueger 2001; Patwardhan 2018). This is especially true for the financial sectors in those countries, where government interference with fiat money serves to affect the returns on investment in speculative environments, which further encourages economic actors to seek returns on instruments that are less subject to those policy decisions. This is especially well evidenced by the "Kimchi premium" in Korea which is the (typically higher) market price in that country as compared to other countries' markets (Choi, Lehar, and Stauffer 2020; Eom 2021; Oh 2018). As a result, governments face a unique challenge to their monopoly over money in the form of often decentralized private currencies which lack central intermediaries to target or regulate.

By extension, governments face the choice of either leaving this challenge unaddressed or working to address the inefficiencies which make cryptocurrencies attractive substitutes by designing and issuing a government digital currency. In this respect, cryptocurrency prevalence serves as the flip side of the domestic push factors described above and stands as a pull factor, in that it influences government decision-making in ways which do not align with pre-existing incentive structures. As a challenge to government monetary privileges, we should expect this factor to produce different preferences and decisions among governments than in the absence of cryptocurrency prevalence.

ii. International Push Factors in Digital Currencies

While domestic factors may shape baseline preferences among governments for digital currency, strategic interaction in government digital money projects is principally a function of international factors facing states. In this respect, international push factors are critical causes of variation in digital currency projects as they serve to clarify whether states have strict or weak preferences for government digital money. More specifically, we should expect governments with strong domestic incentives for or against digital money to update those preferences with consideration of the international costs and benefits of pursuing digital money. In this respect, states which face large domestic economic inefficiencies and widespread cryptocurrency use may pursue alternate solutions to those issues if they do not have sufficient initial incentive at the international level to pursue digital money.

Alternately, even governments with little to no domestic incentive to begin digital currency projects may have a strong incentive at the international level due to push factors which align with preferences regarding interstate relations. The primary international push factors facing countries on the issue of digital money today are issues of political economic subordinance. Among international factors which would affect state choices on government digital money, there are economic and political modes of interstate subordinance.

On one hand, existing government currencies vary with regard to their use in international trade and finance. There is extensive existing scholarship on the international politics of reserve currency status and the political privileges afforded to states whose currencies denominate most global economic activity (Dutt 2020; Friedman 1951; Thornton 2013). In this respect, countries' currency status in global economic exchange stands as a salient economic push factor at this international level which would influence government decision-making on digital currencies. The notion that countries compete politically for currency dominance in the global economy is not only supported by long-standing theory regarding the politics of currency states, but also extensive empirical evidence that currency dominance and subordinance guides state behavior (Cohen 2018b; Kirshner 1997; Strange 1971).

In the case of explicit instances of economic subordinance, we can consider the role of countries' currencies in trade and investment. Specifically, countries with more privileged currency positions in global economic exchange – those which more often denominate international trade and investment relationships – should make choices about government digital money that favor the status quo. Conversely, countries whose currencies less often denominate global economic exchange – and especially countries whose subordinance on this measure is different from its military positioning among other states – will be more likely to pursue digital money choices that challenge the global economic status quo around what government money is and how it is used among countries in the world.

On the other hand, there are more explicitly political push factors at the international level which should affect government preferences for digital currencies. Specifically, the history of issuing and being targeted by international economic sanctions should affect governments' choices around consequential issues of timing, design, and coordination in government digital money, as sanctions are historically used as policy instruments to incentivize policy change in other governments (Eyler 2007; Hufbauer and Oegg 2000; Lindsay 1986).

While international sanctions previously served as blunt instruments which harmed mass publics, the more recent pivot to smart sanctions has very explicitly been designed to optimally incur economic damage on elite decision-makers within governments whose preferences are most relevant to policy making, a pivot which has proven more effective at eliciting policy change through sanctions (Drezner 2011; Gordon 2011). While trade sanctions involve a host of actors and institutions like the WTO, financial sanctions are more commonly applied today and rely explicitly on consensual international standards regarding how money crosses state lines in order to be effective (Drezner 2015). As such, we should thus expect the history of being targeted by sanctions to potentially produce push factors among policy elites which affect decisions around digital government money.

iii. International Pull Factors in Digital Currencies

Push factors are not alone sufficient for understanding strategic interaction in government digital money. Rather, while push factors help to clarify countries with the strongest initial incentives, pull factors help to clarify the ways in which economic and political interdependence can *change* countries' initial preferences through other countries' choices. We can understand the force of this interdependence on states' decisions around government digital money as a function of political economic exposure. As per traditional logic of strategic interaction under complex interdependence, we should expect that countries' mutual linkages in economic exchange and political relations should inform state preferences around digital money independently of the domestic influences or international push factors states face. More simply, because government decisions about digital money do not occur in a vacuum, the critical final class of factors which cause variation in digital currency projects is other states' choices. Here again, both economic and political interdependence among states should serve as international pull factors, updating states' preferences on digital currencies.

Economically, in line with the earlier discussion on economic subordinance, we should expect the largest economic relations among states to be the most salient point of economic interdependence: trade and investment. Economic interdependence along these vectors produces several pull factors for government decision-makers. Because firms enjoy increasing degrees of freedom in which currencies to use for their domestic and international exchange relations (Cohen 2018a), changes in firms choices can affect states' reserve asset distributions and, by extension, create conditions for different dependence structures among countries' currencies and economies. Following this logic, economic interlinkages of any kind between countries - including trade or finance - facilitates some pressure on each state's policies.

This is especially true in one case of economic interdependence: currency exposure, which is the rate of debt among banks in one country held by banks in another country. As explored in scholarship in international and comparative political economy, debt between both private banks and sovereign countries is one of the most significant channels of monetary power within and among states. From Europe (Quaglia and Royo 2015) to Latin America (Frieden 1992), the politics of private debt has had a long-recognized impact on interstate politics (Kahler 1985; Naylor 2004; Soederberg 2013). We need look no farther than the Asian financial crisis (Haggard 2000) or the 2008 financial crisis (Broz 2015) to see how private debt relations across sovereign lines produce sensitivity and spillover among countries.

Politically, there are two channels through which we should expect interdependence to affect states' preferences and decisions around digital currencies: sanctions relationships and co-membership in international organizations. On sanctions, the same logic of experiencing sanctions as a push factor above characterizes the experience of issuing sanctions as a pull factor here. However, sanctions may not be as salient a pull factor among countries as contemporary discussions suggest. On one hand, sanctions are not only inconsistently effective, but they have also become less effective over time due in part to great powers' frequent reliance on them for geopolitical goals. On the other hand, while CBDCs may indeed add new pressure on sanctions system, they do not necessitate a full-scale transition from SWIFT and other enforcement avenues. Indeed, the transition away from SWIFT would require a plurality of members to move toward another system, and would almost certainly require buy-in from the United States which has shown few signs of supporting such a change. At most, sanction-issuing states should be pulled to pursue projects after the states they targeted and to design those currencies in ways which maintain, rather than challenge, the status quo. However, if the challenge to sanctions regimes is insufficiently credible, we should not expect this shift to exist in sanction-issuing states' calculus.

On international organizations, logics of neo-functionalist issue linkages suggest that these institutions facilitate coordination through policy reconciliation, with more recent research suggesting that international institutions can serve as diffusion mechanisms for policy among states who share membership (Simmons and Elkins 2004). Indeed, theres is evidence that policy diffusion operates through organizations in similar cases, like capital taxation policy (Cao 2009; Cao 2010). Existing interstate efforts on private and decentralized digital currencies support this potential spillover in preferences via IGOs. As documented in early work on Bitcoin, the Financial Action Task Force (FATF) has taken lead on global standards for cryptocurrencies, producing striking similarity in cross-border policy design and implementation (Campbell-Verduyn 2018; Campbell-Verduyn 2017; Naheem 2019).

iv. Domestic Permissive Factors in Digital Currencies

Finally, there are a set of domestic permissive factors which shape the feasibility of digital currency projects. Here, I am referring to the domestic conditions which shape the human capital, physical infrastructure, and social interest necessary for research, piloting, and widespread adoption of a digital currency. These factors are by far the most rigorously explored drivers of digital currency choices thus far, and serve as an important foundation for establishing the baseline population of countries which enjoy the option of pursuing digital government money across the world (R. A. Auer, Cornelli, and Frost 2020).

The presence of financial technology firms in the country, and broader degree of a country's technological competitiveness in the world, determine whether the necessary intellectual inputs exist for a digital currency project. Furthermore, because digital money projects are primarily being designed for use on smartphones, the rate of smartphone adoption and cellular phone plans in a country inherently shape the viability for digital currency adoption at scale. Finally, the degree to which countries see interest among consumers for digital currencies matters significantly for incentivizing the transition away from traditional payment systems. In this respect, the prevalence of cryptocurrency-related firms and services in a country stand to increase the viability of digital money projects.

Beyond these domestic permissive factors, though, I also argue that there are permissive factors at the international level which facilitate earlier and faster CBDC projects. Namely, drawing on long lines of research in the international political economy of banking, countries which are more central in the global network of large banks should more readily pursue CBDCs as a function of their privileged position in this network. In line with research on structural power in global finance (Oatley et al. 2013; K. Young 2015; Winecoff 2015), countries whose banking systems are more central to the global banking economy theoretically hold greater leverage and stand to benefit most from early action on CBDCs.

v. Summarizing Causes of Variation in Digital Currency Projects

Collectively, these push, pull, and permissive factors help clarify the dynamic of strategic interaction among states in digital currency projects. While states have pre-existing preferences regarding timing, design, and coordination in government digital money projects, those influences are mediated by international push factors which shape the interstate benefits and costs of different choices in digital money. Finally, while domestic influences and international push factors help to clarify states' baseline preferences for these major outcomes of digital government money, states' preferences are further affected by international pull factors, principally as a function of mutual economic and political interdependence related to money. We can separate these causes of variation in digital currency projects into six groups, differentiated by domestic or international factors that push, pull, or permit countries to pursue digital money. I summarize these causes by dimension in table 2.1.

Table 2.1: Causes of Variation in Digital Currency Projects by Type and Location

Type of Cause	***Domestic Causes***	***International Causes***
Push Factors	Currency inefficiency	Political economic subordinance
Pull Factors	Cryptocurrency use	Political economic exposure
Permissive Factors	Digital infrastructure	Banking centrality

Finally, across all sets of outcomes, I identify a critical mediating factor which spans these different types of causes. Because digital money decisions are made in central banks, and the domestic and international implications of central bank policies mean that the economic priorities of monetary policy may come into conflict with political priorities of other agencies in states' governments (Goodman 1991). This simple fact – that organizations within the state which oversee monetary policy have unique priorities which are either in line with or distinct from other national priorities – has spurred an extensive line of research in political science and political economy on central bank independence (De Haan and Eijffinger 2016). Central bank independence matters because it mediates conflict between stakeholders' priorities in monetary policy decisions (Fernández-Albertos 2015).

Variation in central bank independence has helped to explain a wide variety of political topics, such as its interaction with democracy and inflation across countries (Bodea and Hicks 2015), the credibility of central banks' monetary policy over time (Keefer and Stasavage 2003), and strategies of de-politicizing tough policy decisions by elected officials in difficult trade-offs (Peston 2005). When central banks make choices about whether, when, and how to pursue digital money, I argue that central bank independence importantly mediates the effect of domestic and international push and pull factors, namely by depressing the effects of international push and pull causes and augmenting the effect of domestic push and pull factors in whether, when, and how central banks pursue digital money.

2.4 Testable Hypotheses on Strategic Interaction

This section concludes the theory of strategic interaction in digital government money with testable hypotheses on two main outcomes of interest in this issue area: timing and design of CBDC projects. I expand upon the earlier set of domestic and international push and pull factors with more specific explication of how these factors are specifically expected to produce variation in each of these main outcomes of interest. Importantly, as these outcomes are themselves sequential, they are ordered in this way because expectations around timing also affect theoretical expectations of design choices. As such, I discuss both the push and pull factors which are expected to cause variation in each outcome, and the expectations of how these outcomes also influence other outcomes in their respective sequence.

The section delineates theoretical expectations by the level of outcome variables, rather than by the level of causal factors, for several reasons. First, per the above, the logic of strategic interaction suggests a theoretically important non-independence among these outcomes. More simply, whether and when a country pursues digital money has bearing on design features of their digital currency project. Second, while the causes of variation in each of these outcomes can be explained well by the interaction of domestic and international push and pull factors, the nature of the interaction among these causes varies across each of these outcomes. For example, I theorize that push factors which influence timing of digital currency decisions serve as important pull factors shaping design decisions, due to political and economic interdependence among states. This intersection of causes offers only a piecemeal understanding of variation when organized by cause, rather than outcome. Third and finally, this theory seeks to explain variation in outcomes as a function of strategic interaction. Attention to the causes of effects in digital currency project outcomes, rather than the independent effects of causes, prioritizes an organization of expectations by outcomes.

i. Whether and When Governments Pursue Digital Money

Governments have different incentives to pursue digital money, which shapes their decisions about whether and when to begin digital currency projects. In this respect, there are two classes of states engaging in digital currency projects: first-movers and responders. These classes emerge not only from a review of patterns in countries' digital currency trajectories, but also as a byproduct of theoretical expectations around central bank decisions. Whether a state is a first-mover or a responder is a function of the push, pull, and permissive factors from the previous section. While push factors primarily motivate first-movers' digital currency decisions, first-movers' choices serve as pull factors for responders.

Timing is a critical component of strategic interaction, and in digital currency projects, there are several benchmarks which are critical signals of pace among countries' projects. While various observers organize these benchmarks differently, the common milestones shared among digital currency projects include: signaling interest in digital currencies, beginning research on a government digital currency, beginning development on the digital currency, launching the digital currency pilot among firms and consumers, and finally launching the digital currency for widespread use. Importantly, while the material processes behind each of these benchmarks implies some chronology, the order in which states signal achieving these benchmarks to other actors can vary significantly, with some countries following the order presented above, and others offering initial signals at the stage of research or development. In this respect, whether and when countries pursue digital government money is not only a question of the project pace from start to finish, but also a question of the sequences in which countries publicly signal progress in their respective projects.

First, we should anticipate the pace of projects to vary along push and pull factors. Specifically, as mentioned earlier, we should anticipate first-movers in government digital money to be motivated by domestic causes and international push factors. On one hand, domestic push factors of economic inefficiency such as underbanking and declining cash usage should both motivate countries to move faster on digital government money as a result of their respective alignment with prior policy priorities around money in domestic society. Initial evidence strongly suggests that governments are actively responding to issues of currency inefficiency, as in the cases of Caribbean projects to address financial inclusion (Das 2016) and European projects to address declining cash use (Bank 2020). This yields the following initial expectation on domestic economic inefficiencies and timing of digital money projects:

Hypothesis 1A (H_{1A}): Domestic economic ineffiencies – declining cash use and higher underbanking – push states to pursue digital currency projects earlier and more quickly.

On the other hand, we should also expect international push factors to motivate faster digital currency projects. On issues of economic subordinance, we need look no further than the active goal of de-dollarizing the Asian economy motivating one of the most popular government digital currency projects, the Chinese DCEP. Here, the government has been quite explicit in its goal of unseating the hegemonic role of the dollar in economic exchange by issuing a digital currency with more efficient cross-border clearance mechanisms (Fenech 2019; Huang 2021). On issues of political subordinance, history of being targeted with sanctions stands as the most salient push factor accelerating digital currency projects among first-movers. Here, Venezuela and Russia serve as excellent examples of countries which have explicitly referenced sanctions as a motivation for their digital currency projects.

This relies on the mechanisms by which sanctions are enforced, which is primarily through the Society for Worldwide Interbank Telecommunication (SWIFT) network. Digital currency projects stand to potentially render SWIFT unnecessary if digital currencies are built with their own bespoke clearance mechanisms, a goal of several on-going government digital currency projects (Kirkpatrick et al. 2019; Reynolds 2020). This yields the following additional expectations of international push factors affecting first-movers:

Hypothesis 1B (H_{1B}): International political and economic subordinance – inequalities in networks of global exchange and higher rates of being targeted by sanctions – pushes states to pursue digital currency projects earlier and more quickly.

Consequently, responders include states which make decisions about digital money as a function of their sensitivity and vulnerability to pull factors at the domestic and international levels. Domestically, the predominant motivation pulling countries to pursue digital government money has been domestic rates of cryptocurrency use and fraud, which as described above have served as inconvenient substitutes for government cash and bonds. Many countries have actively discussed that their digital currency projects are in part resentful reactions to the issues raised by digital currency, and in order to solve the chronic social issues to which cryptocurrency use responds (Fonda 2021; S. Kim 2021; A. O. Krueger 2021).

While cryptocurrency use may be correlated with issues like underbanking and cash usage, it is also spurred by popular interest and market volatility yielding often-higher return on interest as compared to traditional financial instruments, suggesting this pull factor is importantly independent from the push factor of currency inefficiencies:

Hypothesis 2A (H_{2A}): Domestic cryptocurrency use among consumers and firms will pull states to pursue digital currency projects earlier and more quickly.

Internationally, the primary pull factor facing countries is political and economic exposure to first movers. Whereas initial hypotheses in the question of whether and when countries pursue digital money pertain to the timing and pace of projects, this final pull factors is instead expected to explain the sequencing of countries' projects in the broader global race for government digital money. As with other issues explored in the literature above, we should expect economic relationships in trade and finance to pull countries to pursue digital money once their peers in international economic exchange have done so.

This relates directly to the pressure associated with firm choice in exchange denomination and consequences for reserve asset status. Politically, we should similarly expect countries' co-membership in international organizations – especially the FATF – to pressure countries to pursue digital money once first movers in those forums have made that decision. This should be especially true in organizations which foster coordination on related issues – namely the WTO (trade), IMF (investment), and UN (sanctions deliberation). This yields the following expectation on international pull factors:

Hypothesis 2B (H_{2B}): International political and economic exposure – including co-membership in intergovernmental organizations and mutual currency exposure in trade and investment among countries – pulls responder states to pursue digital currency projects after first-mover states to which responders are exposed.

Finally, for both first-movers and responder states, we should expect permissive factors to shape the feasibility of digital currency projects altogether, serving as critical control variables for estimating the baseline propensity of a digital currency project in a country. This is not only in line with existing initial evidence around digital currency uptake in general, as evidenced in early research by the Bank for International Settlements (BIS) (R. A. Auer, Cornelli, and Frost 2020). This expectation is also a result of the technical infrastructure demands associated with these projects. As discussed above these should serve as critical baseline drivers of whether, when, and how quickly governments pursue digital money:

Hypothesis 3 (H_3): Countries with permissive factors – human capital and physical and digital infrastructure – will pursue digital currency projects earlier and more quickly.

ii. Design Features of Government Digital Money

Governments have different incentives around how their money is used and how it could be used, which shapes their design considerations in digital currency projects. By design, I here refer to key technical aspects of digital currencies which have material consequences for political and economic relations among countries. At one level, there is simple variation in whether governments are pursuing a wholesale digital currency, for use strictly with financial institutions, or retail digital currencies, which would be used by both institutions and consumers. At a more granular level, there is wide variation in the technology of retail digital currencies which raises significant questions about how consumer-facing digital currencies are designed and used. This section first summarizes the choice menu available to decision-makers in CBDC designs, including architecture, infrastructure, and access technology. I organize and summarize the options available along each feature in table 2.2 by degree of departure from today's status quo. I then turn to two primary questions of interest in CBDC design outcomes, and conclude with testable hypotheses regarding these two outcomes.

Architecture determines the role a central bank will take in managing claims made via a digital currency. Today, most currencies operate on an infrastructure of intermediated claims, wherein central banks maintain a ledger of wholesale transactions with private banks, who bear the responsibility of managing and overseeing retail ledgers with consumers and firms. This is known as the "two-tiered" framework for banking architecture and provides important benefits to both governments and private banks. The current menu of design choices on the dimension of digital currency architecture include indirect, with money being a claim on an intermediary, direct, with money being a direct claim on the central bank, or a hybrid model which differentiates claims by retail or wholesale transactions. Whereas the indirect menu option serves as the digital analog of existing currency infrastructure, the hybrid and direct frameworks are respectively more radical design choices given their implications for reorganizing social relations among economic actors.

Infrastructure determines how digital currency supply is managed and overseen. This refers to the nature of the ledger system which organizes currency supply and movement across actors. Today, most currencies have a centralized infrastructure, and the central bank maintains a ledger of all wholesale currency transactions. While this affords the benefits of coordinated ledger maintenance and hierarchy of control, cryptocurrencies like Bitcoin have offered compelling use cases to central banks for more decentralized ledger solutions. Specifically, some central banks are entertaining the same distributed ledger technology (DLT) used by Bitcoin and other cryptocurrencies, blockchain, as the infrastructure of their digital currency projects. This not only represents a radical departure from standard auditing technology and currency oversight; it also produces important changes in government transparency and macroeconomic monetary policy, for example. As such, whereas the centralized ledger approach is the more traditional design option, the hybrid and decentralized models serve as respectively more radical design choices among government digital currencies.

Access technology refers to how end-users acquire and use the digital currency. On one hand, a digital currency can be accessed in an account framework, wherethrough identity serves as the underlying value transfer mechanism. On the other hand, digital currencies can rely on token frameworks, which use peer-to-peer verification methods, often encrypted, as the underlying value transfer mechanism. As the BIS more simply explains, it is the difference between the respective frameworks of “I am, therefore I own” (account), and “I know, therefore I own” (token) (R. Auer and Böhme 2020). This is another example where a technical feature spells either continuity or disruption for existing social structures across economies. Where our current system of retail currency transactions privileges private banks by granting them the authority of identity verification, per the two-tiered architecture of claims, a token framework would dissolve this privilege by removing intermediary benefits to transactions. An account framework is a status quo design choice available to policy makers in digital currencies, and hybrid and token frameworks are each more radical designs.

Table 2.2: CBDC Design Features and Technical Options

Design Feature	***Status Quo***	***Moderately Different***	***Radically Different***
Architecture	Indirect Claims	Hybrid Architecture	Direct Claims
Infrastructure	Conventional Ledger	Hybrid Infrastructure	Distributed Ledger
Access	Account Access	Hybrid Access	Token Access

We can explain variance along each of these three design outcomes as a function of the push, pull, and permissive factors outlined above, and as a feature of the timing among governments’ digital currency projects. Importantly, while these outcomes pertain to different dimensions of design choices, I argue that they respectively covary along a single dimension: status quo or radical design features. More specifically, because today’s status quo system materially benefits some states over others, some states will rationally have more or less inclination to modify these social structures around government currencies. In variation among status quo or radical design choices, we should again expect political and economic push factors which yield more radical retail digital currencies, and political and economic pull factors which shape design choices by economies which are either privileged or subordinated under the existing status quo. On the issue of similarity, we should see political and economic exposure pulling countries toward similar designs, all else equal.

This theory implies an alignment in outcomes along each of these three major lines of variation. Specifically, countries experiencing greater push factors should be more liberal with regard to the scope and departure from status quo in their digital currency design choices, whereas countries with lower push factors should be more conservative along these dimensions. We can understand these groups as traditional versus radical states on the issue of digital currency design. This initial divide between traditional and radical states with regard to their preferences in digital currency designs can be understood as a function of differences in push factors facing different countries across the world today.

As with the motivations to pursue earlier and faster projects resulting from factors aligning with existing domestic and international priorities, we should again expect that countries with higher rates of underbanking and lower rates of cash usage will more often pursue more radical digital government money designs than others. Internationally, we should again expect political and economic subordinance to encourage more radical design features given the comparative advantages a shift from the status quo could afford:

Hypothesis 1A (H_{1A}): Domestic economic ineffiencies – declining cash use and higher underbanking – push states to pursue more radical digital currency designs.

Hypothesis 1B (H_{1B}): International political and economic subordinance – lower rates of currency use in global exchange and higher rates of being targeted by sanctions – pushes states to pursue more radical digital currency designs.

We should also expect pull factors to shape design choices among countries' projects. In this case, domestic rates of cryptocurrency use among consumers and firms should again pull countries to pursue more radical digital government money design choices than they otherwise would. This expectation is premised on the previously explained logic of private money substitutes and the pressures they create for central banks. In this case, because cryptocurrencies not only alleviate chronic economic issues within a country, but also serve as more lucrative investment options for many actors, we should expect governments to face design competition with digital currencies. As such, because cryptocurrencies stand as radical digital money by design – without centralized authority or managed supply, for example – the pressure to compete with digital currencies should lead governments to select more radical digital currency design choices than they would without that substitution pressure:

Hypothesis 2A (H_{2A}): Domestic cryptocurrency use among consumers and firms pulls states to pursue more radical digital currency designs.

Second, international pull factors should affect government design preferences as they affect decisions around timing. Specifically, we should also expect political and economic exposure to produce pairwise similarity among countries' digital currency projects independently of the factors shaping initial preferences. This is premised on the tensions created by shifting firm preferences for exchange denomination and the implications for reserve asset status and monetary policy flexibility. As other countries pursue more radical digital government money, this has the potential of increasing firms' incentives to denominate exchange in that currency. As such, when countries share high flows of economic exposure, we should expect states to have more similar design features. Similarly, when countries share membership in international organizations, the information flows and coordination pressures that arise within those forums should similarly produce more similar designs choices:

Hypothesis 2B (H_{2B}): International political and economic exposure – including intergovernmental organization co-membership and mutual currency exposure in trade and investment among countries – pulls states to pursue more similar designs.

Finally, as a corollary of these push and pull factors in design choices, we should expect the timing of digital currency projects to affect states' design choices. In this respect, we should expect first-movers to generally pursue more radical designs, whereas responders should pursue more traditional design choices. This expectation is derived from the understanding that the choice by a state to pursue digital currency itself reflects push factors which stem from chronic economic and political issues within a state. As first-movers exhibit higher levels of these push factors, and responders exhibit lower levels, we should expect each to respectively prefer more and less radical design choices as a result.

Hypothesis 3 (H_3): First-movers will pursue more radical design choices than responders.

2.5 Summary of Causes by Outcome

Whether, when, and how governments pursue central bank digital currencies is a process of strategic interaction. Whereas most contemporary research on strategic interaction in monetary issues assumes a static technology of money, today's issues center on *change* in the technology of money and in what government currency is and does in international relations. Like previous strategic interactions among countries involving monetary issues, states face domestic and international push and pull factors around whether, when, and how to make policy. Unlike past examples, this juncture of digital government money involves unique choices available to policy makers, and by extension, is subject to unique causes.

I theorize that states pursue digital currencies earlier than others when they face greater push factors, which later also encourage more radical digital currency design features. Consequently, states which exhibit fewer push factors are liable to respond to these first-movers due to pull factors, beginning projects later and at a slower pace, and pursuing more traditional design options. Collectively, I argue these factors explain the strategic interaction in

Table 2.3: Primary Outcomes and Causes in Digital Government Money

Outcome	***Possible Values***	***Primary Causes***
Timing	First-Mover	Currency inefficiency Political economic subordinance
	Responder	Cryptocurrency use Political economic exposure
Design	Radical (vs Traditional)	Currency inefficiency Cryptocurrency use Political economic subordinance Project timing outcome
	Design Similarity	Political economic exposure

whether, when, and how governments pursue digital currencies. In table 2.3, I summarize each of these main classes of outcomes, the categories of outcomes that can be realized in each class, and the primary pressures theorized to cause each outcome.

Chapter 3

Racing to Reimagine Money

3.1 Introduction: The Race for Digital Money

Why, when, and how quickly do countries across the world pursue digital fiat currencies? Today, central banks are racing to produce digital versions of their sovereign currencies, known as central bank digital currencies (CBDCs). Currently accounting for over 90% of global GDP (Boar, Holden, and Wadsworth 2020), these projects vary widely in progress pace and sequencing. While digital money may appear to be a dry technicality of banking economics, the repercussions of today's work among central banks for political economy cannot be overstated. From disintermediating powerful financial actors, to improving financial inclusion, and even to the possibility of evading international sanctions, CBDCs introduce a wide set of political concerns which directly intersect with issues familiar to international political economy. However, despite these wide-ranging implications, no work has yet addressed the international dimensions of today's race for CBDCs across countries.

While early research has begun to explore the domestic drivers of CBDC project timing, such as rates of cell-phone subscriptions and levels of technical development (R. Auer and Böhme 2020), no research has yet examined the international drivers of whether and when countries pursue CBDC. As explored in the previous chapter, this omission stands in sharp contrast with existing theory in political economy regarding governments' choices around sovereign currencies, whcih suggests that political influences at both the domestic *and* international levels play important roles in affecting these decisions. While this initial work has helped to clarify the baseline conditions which can allow for quicker CBDC projects among countries, it stops short of holistically explaining whether and when governments pursue digital money, and why governments signal progress in these projects at such different rates. As such, the puzzle of why countries pursue CBDCs, and the rate at which those projects progress across the world, remains unsolved in international political economy.

In order to address this important question, this chapter tests theoretical expectations regarding the international political economy of timing in CBDC projects as developed in the preceding chapter. In testing these theoretical expectations, I introduce a novel dataset of CBDC project signals among every central bank in the world. These new data were built based on a new codebook of major and minor benchmark signals applicable to all CBDC projects, as well as other benchmark-independent signals including motivations behind CBDC projects. Recorded at the country-month level between 2008 and 2021, these data include every country recorded in existing repositories, as well as others which those existing collections omit, and constitute a significant contribution to the field of political economy in the opportunities they provide for analysis of CBDC projects across countries.

The chapter proceeds in the following sections. I first describe the new, large dataset of all CBDC project signals with information on the main covariates, and with reference to the codebook for these data that is listed in the appendix for this chapter. I then turn to initial statistical tests on theoretical expectations regarding which countries move first in CBDC timing, and causes of project acceleration among all countries. This section shows robust empirical support for theoretical expectations with descriptive statistics on which countries pursue CBDC, regression models predicting if countries move first and what accelerates projects, and both survival models and sequence analysis to assess entire signal sequences. I conclude with a summary of the main results and specific steps for future research.

3.2 Data: Structure and Contents

In order to test these theoretical expectations, I employ a wide battery of descriptive and inferential statistical models, ranging from standard approaches like OLS and logistic regression to more specialized tools like survival models and sequence analysis. Before proceeding to the statistical tests of these theoretical expectations, though, I first describe in this section the key dependent and independent variables employed in those models.

i. Dependent Variable: CBDC Progress Signals

This project introduces a new dataset of signals by central banks regarding the progress in their respective digital currency projects. The dataset constitutes a contribution to the fields of political science and economics in its organization and coding of these signals for use in future research, with an initial use case demonstrated here. The dataset is built both from existing compilations of CBDC projects among several major repositories, and manually augmented by human coders with reference to governments' central bank websites and other primary and secondary sources on which those existing collections are built.

The primary dependent variable derived from this dataset is a country's maximal level of publicly-signaled CBDC progress in a given month and year. Because public signals about CBDC progress are reliably measured at the country-month-year level, these data allow for significantly more granular analysis of cross-sectional and over-time project progress than existing snapshot collections allow. The major benchmarks include the following categories, and take respective values of 0 through 6 in the following order: (0) No Progress, (1) Interest, (2) Research, (3) Development, (4) Pilot, (5) Launch, and (6) Termination. While the full definition for each of these major benchmarks and their constituent minor benchmarks is included in Appendix Section 3.5, I describe each here for interpretation of score values.

Interest is observed when the government or central bank has indicated an interest in sovereign digital currencies, by either holding an initial discussion on a prospective project, announcing formal interest in pursuing a CBDC, or organizing a team before conducting any work. Research is observed when the government or central bank has begun formal research on digital currencies for their country, by either announcing the onset of formal research activities or publishing finished or in-progress research on feasibility, design, or payment applications. Development is observed when the government has begun to build a pilot of their digital currency, including by announcing the onset of formal development activities or demonstrating development in either design choices or interoperability applications.

Piloting is observed when the government is testing a pilot prototype of their digital currency with actual firms and consumers, typically including the announcement, onset, or expansion of a pilot project, or evaluating outcomes of a pilot project. Launching is observed when the government has launched the CBDC for widespread use in the country, either with the announcement, onset, or expansion of CBDC issuance to consumers and firms outside of pilot projects, or evaluating the outcome of a broad launch. Finally, Termination is observed when the government has announced the digital currency project is being ended, indicated either by the announcement or finalization of a project's end.

As explained in the codebook at further length, the data also another important variable: CBDC project motivation. Motivations are binary codes at the signal level indicating whether the government announcement referenced any of the following eight unique motivations derived from qualitative review of the full set of announcements: financial incklusion, declining cash use, banking efficiency (domestic), cross-border payments (international), evading international sanctions, precautionary action, transparency, or financial stability. While these categories are typically self-evident in the language of announcements, the criteria for binary codes along each of these categories is reported in Appendix Section 3.5.

ii. Independent Variables: Push, Pull, & Permissive Measures

The empirical results in the next section offer tests of the primary push, pull, and permissive factors outlined in the theory section above. This section briefly explains the measures constructed to test each theoretical variable in the statistical models presented below, including the source and, where appropriate, statistical transformation of the empirical data.

Variables that measure permissive factors in the framework presented earlier include GDP per capita, rate of inflation, cellphone subscriptions per capita, government effectiveness, technology sector competitiveness, level of financial development, and central bank independence, in line with variables tested in other early work on this issue (R. A. Auer, Cornelli, and Frost 2020). GDP per capita includes the ratio of GDP (USD) and population which, alongside GDP deflator inflation and per capita cell-phone subscription measures, were accessed from the World Bank and measured on a country-year level. Government effectiveness is drawn from the World Bank survey and reported on a yearly basis with the most recent score to each panel of survey data by country. Technology sector competitiveness is measured with the WIPO global ranking of technical competitiveness and reported on a country-year basis (WIPO 2020). Financial development is drawn from the IMF estimation widely used in political economy research (Svirydzenka 2016), and central bank independence draws on the dataset with the broadest, most recent coverage (Garriga 2016).

The primary independent variables derived from theoretical expectations regarding push factors include currency in circulation, rate of financial inclusion, counts of cryptocurrency ATMs, counts of cryptocurrency exchanges and volume on those exchanges, centrality in global networks of corporate banking boards, and subordinance in global networks of interstate trade and investment. Currency in circulation, being notoriously difficult to estimate for any meaningful proportion of countries across the world (Khiaonarong and Humphrey 2019), is proxied with country-year measures of broad money in circulation, normalized by GDP estimates, in line with best practices identified on this issue. The number of cryptocurrency ATMs is cumulative counts of reports recorded at a country-month level, provided by CoinMap's API (*CoinMap Cryptocurrency ATM API* 2021).Cryptocurrency exchange count and volume are aggregated at the country-month level, provided by CryptoCompare, the largest public repository of crypto-exchange data in the world (*CryptoCompare* 2021).

Centrality in the global network of corporate banking boards is estimated using Orbis data on all corporate boards for all active banks in every country with revenue above $25million (*Orbis Corporate Board Data* 2021). Following procedures applied widely in American and international political econony (Marple, B. Desmarais, and K. L. Young 2017; Marple 2020; K. L. Young, Marple, and Heilman 2017), I construct a network of countries connected by the number of shared board members across their constituent banks. I estimate centrality as the normalized degree centrality of each country, or simply the proportion of all possible ties to other countries that each country has (Jackson 2005).

Subordinance in global networks of interstate trade and investment are similarly estimated as network measures. I construct a network of trade and investment with IMF direction of trade data (*IMF Direction of Trade Statistics* 2021) and outward FDI data (*IMF Outward FDI Statistics* 2021), for each year and estimate two centrality measures for each country: normalized degree centrality and eigenvector centrality. While normalized degree centrality is the same proportion of all possible ties held by each country, eigenvector centrality normalizes this value by the popularity of each country's neighbors in the network (Wasserman, Faust, et al. 1994). A positive value indicates countries subordinate to their neighbors in either network, in line with long-standing sociological theory on status inconsistency in social networks and implications for actor preferences on status quo rules and standards (Stryker and Macke 1978; Askin and Bothner 2012; Jensen and P. Wang 2018).

Finally, the primary pull factor variables include five measures of interstate exposure: intergovernmental organizations, investment, trade, sanctions, and banking board interlocks. Each measure is derived from relational data, respectively capturing co-membership in IGOs (Pevehouse et al. 2020), outward FDI (*IMF Outward FDI Statistics* 2021), directed trade (*IMF Direction of Trade Statistics* 2021), directed sanctions Felbermayr et al. 2021, and Orbis board interlocks (*Orbis Corporate Board Data* 2021). Each indicator measures the proportion of a state's network neighbors which have begun CBDC projects each month.

3.3 Empirical Results

This section reports empirical tests of the theoretical expectations on four distinct outcomes: whether countries ever pursue CBDC in these data, why some countries begin work first, why countries accelerate their projects over time, and why countries send distinct patterns of progress signals about their respective CBDC projects.

i. Which countries ever pursue CBDC?

There are notable differences among countries that do and do not pursue CBDC projects. While the primary purpose of this project is to assess motivations for moving first and for accelerating projects across countries that eventually pursue CBDCs, in this section I briefly contour the correlates of CBDC pursuit among countries.[1]

Economically, countries which pursue CBDCs are larger, with approximately 7 times larger GDP than countries which have not pursued CBDCs. This supports the findings that even with the current 70 projects across the world, the vast majority of global GDP is affected by these current CBDC efforts (Boar, Holden, and Wadsworth 2020). Although inflation is not significantly different among countries with and without CBDC projects, the ratio of broad money (in circulation) to GDP is significantly higher among CBDC countries (approximately 1.5 times larger) than in countries without CBDC projects. Along IMF scores for financial development, CBDC-pursuing countries are significantly more developed on this dimension (mean of 0.44) than their non-CBDC counterparts (mean of 0.19).

Countries with any history of pursuing CBDC projects also have higher rates of permissive factors outlined in the theory, as evidenced in earlier research and supported in this analysis. In terms of cellphone subscriptions per capita, countries pursuing CBDCs have significantly higher scores on this variable than countries no history of pursuing CBDC projects. There is some initial support for the role of government effectiveness, with an average 1-point difference between CBDC and non-CBDC countries using the World Bank index. However, countries pursuing CBDCs score significantly lower on the WIPO global innovation index (mean of 50) than non-CBDC countries (mean of 90), suggesting that private sector technical competitiveness is inversely related to CBDC efforts, counter to initial expectations and tentative results presented on smaller samples elsewhere.

Interestingly, there is strong initial support for push factors facing CBDC decisions in these correlates. CBDC countries have significantly higher rates of reported cryptocurrency ATMs and exchanges, and among those exchanges CBDC countries have significantly higher volume than non-CBDC countries. Furthermore, CBDC countries score significantly higher on network subordinance in both trade (about 0.15 points higher) and FDI (about 0.14 points

[1] Importantly, because countries are entering this strategic race and accelerating projectes every day, these correlates may eventually become moot once all countries across the world adopt CBDCs.

higher), supporting the push factors outlined at the international level as well. However, while these initial correlates help to clarify the population of countries who ever engage in a project, they offer limited adjudication regarding countries' choices to move first, and to accelerate their projects once those projects have begun. In the following sections, I turn to each of these questions with a battery of statistical tests to triangulate support for my theory regarding domestic and international push and pull factors. Table 3.6 reports variable averages, estimated difference, and whether the difference is significant at $p < 0.05$.

ii. Why do some countries move first?

Some countries begin CBDC work before any of their immediate economic neighbors. As per the theory outlined earlier in this manuscript, we can consider these countries to be first movers in the domain of digital government money. While there are many ways to categorize a first mover in global policy adoption, the argument set forth in this chapter centers on issues of economic and political ties among countries.

In this respect, the analysis below identifies first movers as countries which began any work on CBDC projects before 5% or more of their trading partners in the preceding 5 years began development on their CBDC projects. Following this definition, 20 of the 70 unique countries pursuing CBDC projects are first-movers, not including monetary unions.[2] These first movers are tabulated below in table 3.1. The table includes not only the date at which each country started work on their respective CBDC projects (column 2), but also the average score for the project across all time (column 3) based on the 6 point scale.

Table 3.2 reports the results of a logistic regression model predicting a country as an active first mover; this takes a value of 1 if a first mover has a live project at time t, and a value of 0 otherwise. While column 1 presents evidence for control and permissive factors as baseline drivers of first mover projects, columns 2 and 3 respectively augment the model with push factors at the domestic and international level which are expected to motivate first mover project work. These results offer initial support for theoretical expectations around first-moving countries in CBDCs. Namely, model 1 adjudicates baseline expectations that first-moving countries have generally larger economies with higher rates of inflation, as well as higher rates of permissive factors like cell phone subscriptions per capita. Furthermore, model 1 supports expectations that these are less financially developed countries with less competitive domestic technology sectors. While model 1 shows a negative relationship between government effectiveness and proclivity to pursue CBDCs first, this effect reverses and is inconsistently significant in the other two models. However, the results strongly support expectations on central bank independence inhibiting first movement, and centrality in global banking networks motivating first-movement among countries; these estimates remain consistent even alongside the other push factors added in models 2 and 3.

[2]The analysis presented in this chapter omits two projects which are not led by single countries, but rather by entire monetary unions: the Eastern Caribbean Central Bank (ECCB) and the European Union (EU). Because these CBDC projects are issued by collections of countries, they do not fit theoretical expectations regarding inter-state pressures and have prior monetary cooperation implying distinct causal pressures.

Table 3.1: First Mover Countries Pursuing CBDC Before Trade Partners

Country Name	Start Date	Avg. Progress Score
Ecuador	11/2013	2.98
China	1/2014	1.85
United Kingdom	2/2015	0.98
El Salvador	9/2015	2.25
Tunisia	12/2015	1.31
Ukraine	5/2016	1.35
South Africa	6/2016	1.12
Canada	11/2016	0.81
Sweden	11/2016	1.09
Singapore	11/2016	0.88
Senegal	12/2016	1.8
Hong Kong	4/2017	0.89
Cambodia	4/2017	1.14
Bahamas	5/2017	1.04
United Arab Emirates	9/2017	1.53
Malaysia	9/2017	0.61
Uruguay	9/2017	1.22
Israel	11/2017	0.66
Venezuela	12/2017	1.44
North Korea	9/2019	0.49

Notably, models 2 and 3 offer strong support for theoretical expectations on push factors motivating first-movers at the domestic and international levels, respectively. Model 2 shows support for domestic push factors explaining first movement; although financial inclusion scores are small and insignificant, and cryptocurrency ATM counts run counter to expectations, broad money in circulation normalized by GDP, and the count and volume of cryptocurrency exchanges in a country are positive and significant predictors of first-mover status. As I show in model 3, these positive and significant predictors remain comparable when augmented with push factors at the international level. Here we see support for one international push factors motivating first movers in CBDCs, subordinance scores in the global trading network. While effects subordinance in the global FDI network run counter to theoretical expectations, this coefficient changes both sign and significance in various robustness tests, as discussed below.

These main results are robust to a variety of alternate model specifications. As I show in table 3.7, results are consistent when specified in a rare events regression model that accounts for actual intercept estimates from the base data to correct model bias ($\tau = 0.035$) suggesting that predictor significance is not a byproduct of misestimated intercept coefficients for active

Table 3.2: Logistic Regression for Active First Mover CBDC Projects

	Dependent Variable: Active First Mover (Binary)		
	(1)	(2)	(3)
GDP per capita	0.773***	0.982***	0.963***
	(0.108)	(0.116)	(0.117)
Inflation	0.004***	0.006***	0.006***
	(0.001)	(0.001)	(0.001)
Cellphone per capita	0.008***	0.008***	0.008***
	(0.001)	(0.001)	(0.001)
Gov. Effectiveness	−0.097	0.210**	0.108
	(0.084)	(0.100)	(0.105)
WIPO Index	−0.023***	−0.032***	−0.034***
	(0.002)	(0.002)	(0.003)
Fin. Dev. Index	−3.216***	−5.419***	−5.248***
	(0.324)	(0.444)	(0.444)
Central Bank Independence	−2.740***	−0.696**	−0.673**
	(0.247)	(0.275)	(0.274)
Orbis Network Centrality	1.960***	1.433***	1.283***
	(0.176)	(0.224)	(0.232)
Broad Money to GDP		0.084***	0.090***
		(0.006)	(0.007)
Financial Inclusion		−0.003	−0.003
		(0.002)	(0.002)
Crypto ATM Count		−0.068**	−0.080***
		(0.031)	(0.031)
Crypto Exchange: Count		0.103***	0.122***
		(0.021)	(0.025)
Crypto Exchange: Volume		0.034***	0.036***
		(0.007)	(0.007)
Trade Subordinance			0.700***
			(0.257)
FDI Subordinance			−0.395*
			(0.209)
Year	0.538***	0.550***	0.553***
	(0.021)	(0.024)	(0.024)
Constant	−6.310***	−6.239***	−6.429***
	(0.407)	(0.438)	(0.459)
Observations	20,207	16,898	16,898
Log Likelihood	−3,137.553	−2,656.703	−2,651.660
Akaike Inf. Crit.	6,295.106	5,343.405	5,337.321
Note:			*p<0.1; **p<0.05; ***p<0.01

first movers. Furthermore, as I show in table 3.8, these results remain consistent when estimated in a standard OLS model with a variety of fixed effects specifications. Notably, when controlling for country and year fixed effects, some control predictor estimates change sign and significance, such as cell phone subscriptions per capita and financial development index effects, but the primary theoretical predictors of cryptocurrency exchange volume and trade network subordinance remain significant positive predictors of active first-mover status. As I show in table 3.9, these coefficient estimates remain comparable when clustering standard errors on the country level with these fixed effects specifications, suggesting that these are robust predictors of first mover status.

iii. Why do countries accelerate projects?

As outlined in the theory section, first movers constitute only half of the strategic interaction dynamic facing states in the issue area of CBDCs. As such, while we now have initial evidence supporting theoretical expectations for which countries move first in pursuing CBDCs, we may now ask what factors are associated with project acceleration among responding countries. In these analyses, I limit the analysis to only countries which have pursued a CBDC project at any point in the dataset, including the first movers identified in table 3.2. I omit countries which have not pursued any CBDC in order to estimate the effects on project acceleration where the outcome variable could meaningfully be observed among country-time units. However, as I discuss later in this section, these results are robust to including countries which have not pursued a CBDC at any time in the dataset.

Table 3.3 reports OLS regression estimates for project scores across a battery of control, push, and pull factor predictors outlined in the theory. Model 1 offers similar support for baseline control expectations around project progress among any CBDC-pursuing country, again showing higher GDP and higher inflation, alongside lower technology sector competitiveness and lower financial development, as predictors of accelerated progress in CBDC projects. Again, we see results counter to expectations with cell phone subscriptions as a negative predictor, and unlike in table 3.2, we see a positive and significant result for government effectiveness as an accelerant among CBDC projects. Model 2 shows support for some push factor expectations. Broad money and financial inclusion are insignificant, and cryptocurrency ATM counts are negative and significant counter to expectations. However, here again, the count and volume of cryptocurrency exchanges is a positive and significant predictor of project status among countries pursuing CBDCs in the data.

Models 3 and 4 offer further evidence for the domestic and international pull factors expected to shape project status. While trade and FDI subordinance were significant positive predictors of first-mover status in earlier tests, they provide insignificant results in model 3. In model 4, with addititional international pull factors included, these are mixed, with trade subordinance negatively associated with project development and FDI subordinance positive. However, several key interstate pull factors align strongly with expectations. While FDI and sanctions exposure are insignificant, IGO and export exposure positively and significantly predict project status acceleration per theoretical expectations. Counter to expectations,

Table 3.3: OLS Regression for CBDC Project Status Among All CBDC-Pursuing Countries

	Dependent Variable: Responder Project Progress (Value: 0-6)			
	(1)	(2)	(3)	(4)
GDP per capita	0.214***	0.114	0.120*	0.161**
	(0.073)	(0.071)	(0.072)	(0.071)
Inflation	0.009***	0.008***	0.008***	0.006***
	(0.001)	(0.001)	(0.001)	(0.001)
Cellphone per capita	−0.006***	−0.005***	−0.005***	0.001***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Gov. Effectiveness	0.045*	0.106***	0.105***	0.109***
	(0.026)	(0.027)	(0.028)	(0.026)
WIPO Index	−0.002***	−0.001*	−0.001*	0.001**
	(0.001)	(0.001)	(0.001)	(0.001)
Fin. Dev. Index	−0.111	−0.322***	−0.324***	−0.181
	(0.112)	(0.120)	(0.120)	(0.113)
Central Bank Independence	0.424***	0.512***	0.498***	0.201***
	(0.075)	(0.074)	(0.074)	(0.070)
Orbis Network Centrality	−0.006	0.084	0.093	0.089*
	(0.056)	(0.057)	(0.058)	(0.054)
Broad Money to GDP		0.003	0.003	0.005**
		(0.002)	(0.002)	(0.002)
Financial Inclusion		0.001	0.001	−0.001**
		(0.001)	(0.001)	(0.001)
Crypto ATM Count		−0.077***	−0.077***	−0.036***
		(0.009)	(0.009)	(0.009)
Crypto Exchange: Count		0.020***	0.018**	0.006
		(0.008)	(0.008)	(0.008)
Crypto Exchange: Volume		0.029***	0.029***	0.026***
		(0.003)	(0.003)	(0.003)
Trade Subordinance			−0.068	−0.316***
			(0.067)	(0.063)
FDI Subordinance			−0.052	0.249***
			(0.059)	(0.056)
IGO Exposure				5.192***
				(1.010)
FDI Exposure				0.239
				(0.192)
Export Exposure				0.708***
				(0.177)
Sanctions Exposure				0.005
				(0.006)
Board Interlock Exposure				−1.622***
				(0.077)
Year	0.173***	0.174***	0.176***	0.033***
	(0.003)	(0.004)	(0.004)	(0.007)
Constant	−0.340**	−0.318**	−0.274*	−0.423***
	(0.145)	(0.143)	(0.146)	(0.140)
Observations	9,519	9,449	9,449	9,449
R^2	0.427	0.438	0.438	0.513
Adjusted R^2	0.426	0.437	0.437	0.512
Residual Std. Error	1.052 (df = 9509)	1.017 (df = 9434)	1.017 (df = 9432)	0.947 (df = 9427)
F Statistic	786.429*** (df = 9; 9509)	525.823*** (df = 14; 9434)	460.241*** (df = 16; 9432)	472.661*** (df = 21; 9427)
Note:				*p<0.1; **p<0.05; ***p<0.01

corporate board interlock exposure is a significant and negative predictor of project status, implying a unique process operating across interstate banking networks.

Here again, these results are robust to various alternate model specifications. Table 3.10 shows that all results from models 1 through 4 in table 3.3 are consistent when estimated with HC1 standard errors, and as I show in table 3.11, the main results from table 3.3 model 4 are largely consistent when specified in an ordinal logistic regression model treating each cumulative project status as its own factored outcome, with FDI exposure positive and significant and IGO exposure smaller and insignificant. Further, as I show in table 3.12, all results from table 3.3 are consistent when the same OLS models are specified on the full dataset including countries which never pursue a CBDC at all. In these tests, some key predictors such as board exposure flip signs and align with theoretical expectations, suggesting they are associated with only low levels of progress as compared to countries with no progress. Finally, even when accounting for the Covid-19 pandemic, these predictors remain largely consistent, as shown in table 3.15, using *OWID* data (Roser et al. 2020).

Notably, these results offer some insights into a particular facet of current debate on the international politics of CBDC timing: the effects of China's project. While this has been a significant point of contemporary discourse, no empirical work has yet assessed the extent to which progress in the Chinese CBDC, known as DCEP, is affecting trends in other countries' projects. Given the structure of the data used in this analysis, it is possible to assess this effect. A simple approach here involves specifying the same model presented in table 3.3 on data including all countries' projects except for China's. When including a covariate in this model for the state of China's project, the effect is statistically significant, showing that for every one unit of reported progress in the DCEP, other countries' projects accelerate by approximately 0.05 points. Indeed, when adding another indicator controlling for the global average progress in a given year (with $\beta = 0.83$ for the global average effects), the effect of one-unit increase in reported DCEP progress increases to 0.1. This suggests that, on average, the full-scale completion of China's project is associated with approximately 0.5 points increased progress in every other country's project, even when controlling for the pull effects detailed in the results above. Results from both models are presented in table 3.16.

iv. Why do projects move at different paces?

Finally, after establishing support for theoretical expectations regarding both first-mover status and drivers of progress acceleration, we may now examine the timing of project progress signals among countries. In this section, I explore two primary outcomes associated with project timing: the propensity to make a first project progress signal among all countries per unit time, and the patterns of similarity among countries entire progress signal sequences.[3]

[3] In both of these analyses, I delimit the data to only observations including countries which pursue CBDC at some point in the data. This is designed to allow for defensible null assumptions behind these models, that a first signal or project sequence exists but varies for reasons beyond baseline propensity factors.

i. Survival to First Signals

First, we can explore the drivers behind countries' first progress signals. Simply, what motivates countries to announce their first action on CBDCs? As I show below, we can visualize the race to first action in CBDCs with standard survival model hazard projections. Figure 3.1 presents both the general hazard for first CBDC signals across all countries (left panel), and the same plots for each type of country, first-mover and responder, including a risk table per unit time (right panel). One notable trend can be observed from panel 2, which is that responders' first signals appear to have occurred only after all first movers have issued their own first signals, suggesting strongly that this differentiated categorization of countries remains analytically useful for examining projects.

Table 3.4 reports the results of two survival models for CBDC signals beyond interest, independent of the status of the project announced in that signal. Model 1 reports the first signal sent by any country, where model 2 accounts for the first *response* signal, namely by counting the *second* signal among first-movers and first signal among responders. As per conventions for survival analysis, observations are dropped (censored) after the first realization of an outcome. In line with results presented previously in tables 3.2 and 3.3, we again see support for both push factors among first-movers and pull factors among responders. Notably, whereas trade subordinance was the primary significant predictor for active first mover status at any point in the dataset, FDI subordinance is here the positive and significant predictor of first signals among first-moving countries. Comparably, we see FDI exposure as a negative predictor of first signals among responder countries, in model 2, but trade exposure remains a large, positive, and significant predictor in both specifications.

Notably, few main predictors remain significant in these specifications, due likely to the much lower number of observations when specifying on first signals and to the particular assumptions around the distribution of survival propensities. However, these results remain consistent in effect size estimate when the model does not cluster on country ID, as I show in table 3.17. However, as is highlighted in foundational work on survival models (Box-Steffensmeier and Zorn 2001; Liu 2012), the distributional assumptions necessary for robust causal inference on multistage data like these demand an entire manuscript for full exploration, standing as a significant line of future research. Indeed, as I explore in the final analysis in this section, the high diversity in the type of signal that countries send first about their CBDC projects may produce important differences in the causal factors motivating a first signal. Because these signals are public statements, and not necessarily reflective of actual material progress occurring more quietly within central banks, future analysis of these data should analyze known or imputed material rates of progress for clearer model fits.

ii. Assessing Full Signal Sequences

As the first signal a country sends about its CBDC project is, by definition, the beginning of a longer sequence, we may now turn to analyzing the entire sequence of progress signals among all CBDC-pursuing countries over the full time-span of the dataset. In order to systematically

Figure 3.1: Survival Plots for Time to First Action Among CBDC-Pursuing Countries

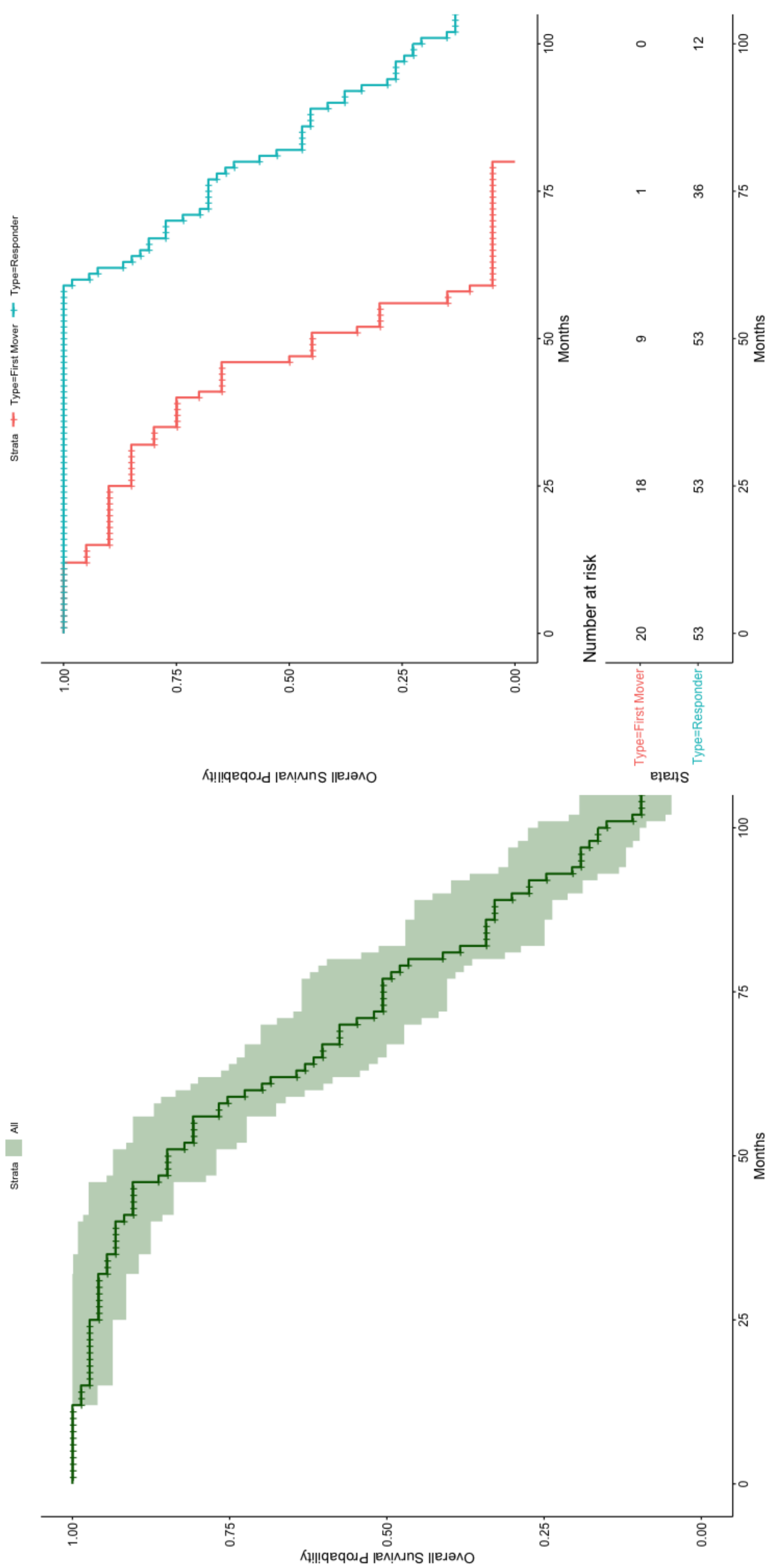


Table 3.4: Survival Model for First Project Signal Among CBDC-Pursuing Countries

	Dependent Variable: Survival to First Action	
	(1)	(2)
Central Bank Independence	1.246	0.103
	(1.209)	(0.973)
Orbis Network Centrality	1.589*	−0.456
	(0.904)	(0.830)
Broad Money to GDP	−0.010	−0.011
	(0.033)	(0.022)
Financial Inclusion	−0.010	−0.006
	(0.009)	(0.007)
Crypto ATM Count	0.012	0.222**
	(0.135)	(0.109)
Crypto Exchange: Count	0.062	−0.035
	(0.168)	(0.077)
Crypto Exchange: Volume	0.057*	0.016
	(0.039)	(0.025)
Trade Subordinance	−1.754	−1.673**
	(1.363)	(0.878)
FDI Subordinance	2.280**	2.110***
	(0.992)	(0.833)
Responder	−7.244***	−0.168
	(2.426)	(0.403)
IGO Exposure	−55.468**	−42.690*
	(27.847)	(22.117)
FDI Exposure	−6.289	−62.076
	(60.579)	(63.932)
Export Exposure	65.341***	29.345**
	(27.557)	(18.810)
Sanctions Exposure	−3.969***	−1.473***
	(1.020)	(0.488)
Board Interlock Exposure	1.203	0.560
	(1.902)	(1.250)
Event Type	First Signal	First Response
Observations	3,930	4,625
R^2	0.026	0.007
Max. Possible R^2	0.080	0.089
Log Likelihood	−111.536	−199.492
Wald Test (df = 15)	62.210***	56.460***
LR Test (df = 15)	105.012***	33.510***
Score (Logrank) Test (df = 15)	221.572***	37.300***
Note:		*p<0.1; **p<0.05; ***p<0.01

map and analyze the full set of progress signals and states among these countries, I turn to a method used primarily in sociology: sequence analysis. This method, initially developed to analyze genome sequences, has become increasingly useful in the social sciences for visualizing and statistically analyzing lifecycles among individuals and organizations (Gribskov and Devereux 1993; Abbott 1995; Brzinsky-Fay and Kohler 2010). Some more recent work in political science has applied sequence models to assess the importance of timing, beyond simply substance, of choices in political processes (Pierson 2000).[4]

First, we can visualize all countries' respective progress sequences in a pooled plot, as shown in figure 3.2. This figure depicts all full project sequences organized by most (top) to least (bottom) advanced projects, with each bar along the y-axis constituting one of the 70 distinct CBDC projects included in the data.[5] As is clear, countries vary significantly with regard to the time of their first signal (length of green bar preceding any active sequence state) and with regard to the actual state sequences of their announced CBDC project progress, per the diversity in length and order of color sequences described in the plot legends.

As these sequences are generated from numeric progress states, ranging from 0 (no progress) to 6 (termination of CBDC project), we can cluster sequences as a function of their minimal pairwise dissimilarity in time-state status. For this exercise, I offer a non-parametric clustering of all country sequences in order to assess how pairwise dissimilarity clustering, relying on the Wald method for matrix distance solutions, produces unique clusters of country sequences. Figure 3.3 presents the clustered sequences, with $k = 2$ clusters, which produced the most balanced organization of observations.[6] Country assignment to each cluster is reported in table 3.18 with reference to the panels in figure 3.3.

There are interesting correlates of cluster assignment and countries' sequence characteristics. First, in line with a visual inspection of these plots across clusters, first movers are significantly more likely to be assigned to cluster 1. Simple bivariate results suggest that first-movers are 3.8 times more likely to be assigned to cluster 1, with 95% of first-movers in this cluster as opposed to 30% of responders assigned to this cluster. Second and relatedly, first-movers have significantly higher scores on three theoretically relevant sequence indicators that capture volatility in signals: (i) entropy, which measures time in each state normalized by the length of time in any state, (ii) turbulence, which measures number of sequence states normalized by the variance of time in each state, and (iii) complexity, which measures entropy against state transition counts (Gabadinho et al. 2011, pp. 22-23).

As I show in table 3.5, first movers and members of cluster 1 score significantly higher along these measures, indicating more nuance in project development due likely to longer time spent working on projects. First movers have approximately 24% higher sequence

[4]For in-depth review of sequence analysis' applications to political science research, see Blanchard 2011.

[5]There are two alternate common means of organizing sequences in a pool, both of which hinge on pairwise similarities of sequences along a clustering method which identifies the longest common subsequence (LCS) problem. The first approach, as shown in figure 3.4, organizes sequences by their distance to the first factor in the LCS solution, whereas the second approach, shown in figure 3.5, organizes sequences by their distance from the most frequent factor in the LCS solution

[6]All outcomes with $k > 2$ produced clusters with 6 or fewer countries, offering little inferential value.

Figure 3.2: CBDC Project Progress Signal Sequences Across All Countries

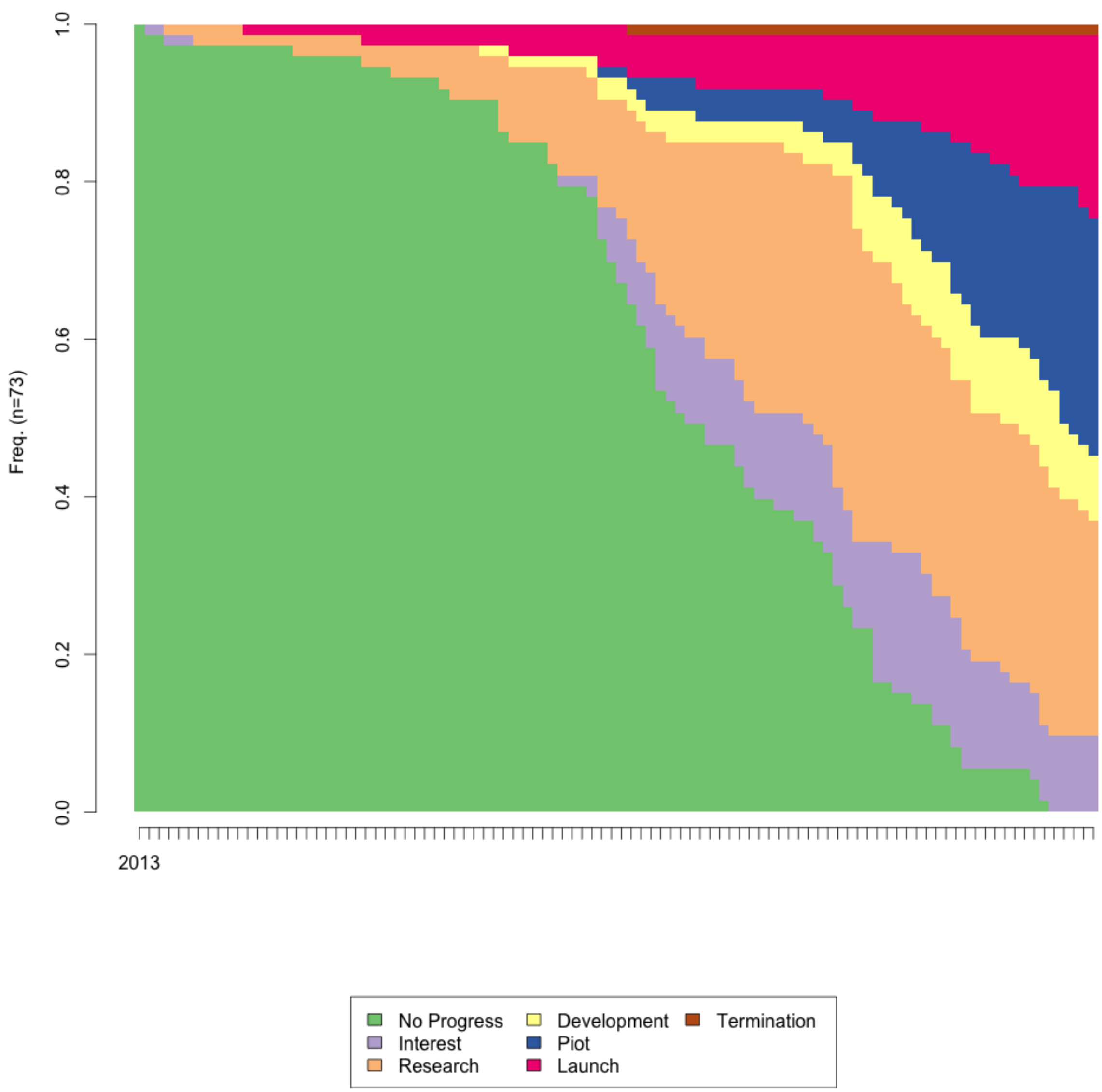
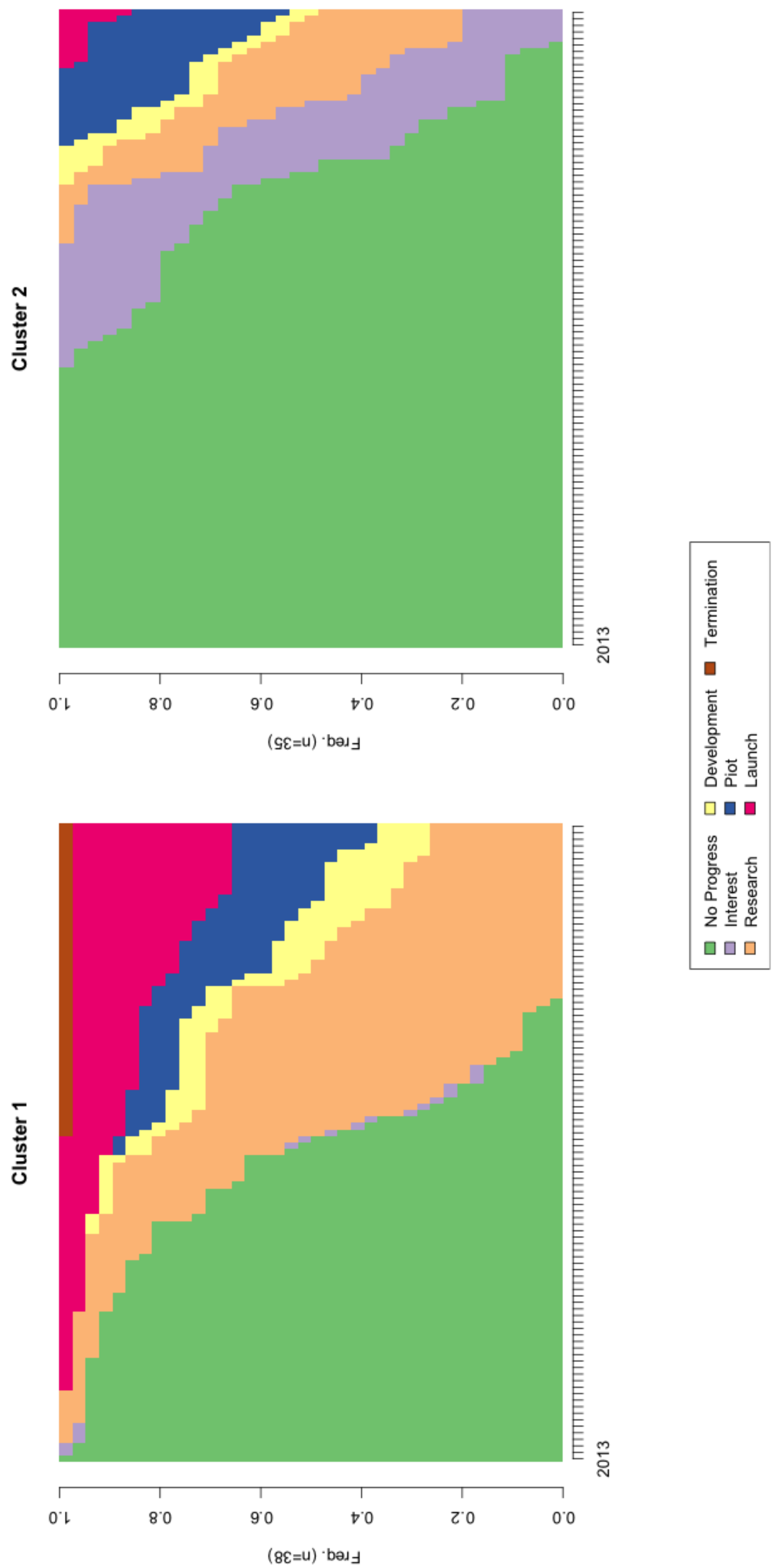


Table 3.5: T-Test Results for Differences in Sequence Scores by First-Mover and Cluster

Measure	First Mover	Cluster 1
Entropy	24.19%∗∗	30.98%∗∗∗
Turbulence	42.63%∗∗∗	60.49%∗∗∗
Complexity	15.8%	17.29%∗

Figure 3.3: Wald-Clustered Sequences Among All CBDC-Pursuing Countries



entropy, 43% higher sequence turbulence, and 16% higher sequence complexity than responder states. Given the high likelihood of first-mover assignment to cluster 1, we see similar mappings with 31% higher entropy, 60% higher turbulence, and 17% higher complexity in cluster 1 members' project sequences as compared to cluster 2. These results offer important conditioning evidence regarding the earlier support for hypotheses on timing.

As each of these indicators measures the volatility of progress signals in a CBDC project sequence, these results suggest that after a country has entered the race for CBDCs, it is exceedingly difficult to predict the direction of their future activities across these major benchmarks. While earlier results offered strong support for hypotheses on which countries move first and what motivates countries to accelerate projects, these results suggest high degrees of volatility among countries with more developed projects, implying an *increasingly* complex coordination problem as the race for CBDCs progresses. In terms more familiar to political scientists, the obstacles to an international CBDC regime become higher as the race proceeds. This result, paired with evidence on international pull pressures and the absence of globally consensual rules and norms around CBDC projects, implies a strong incentive for all countries to proceed yet more aggressively with their respective CBDC projects.

3.4 Conclusion

Countries across the world are racing to reimagine the technology of government money. While early work has explored the domestic correlates of CBDC choices among countries in the world, this research remains limited in its capacity to explain international drivers of variation in project timing. In this chapter, I tested expectations derived from a new theory of whether, when, and how quickly countries pursue CBDC, unifying both domestic and international expectations which align with and depart from prior policy preferences. Using a new dataset of all public signals of CBDC project progress across every central bank in the world, I identify support for this theory across four sets of empirical tests, which remain consistent under a wide variety of alternate model specifications. Broadly, this evidence suggests strongly that governments are not only sensitive to domestic conditions which push them toward CBDCs, but are also vulnerable to pressures from other countries' choices.

These results, premised on a first-of-its-kind dataset of CBDC project progress, pave a long road of future research for the international political economy of CBDCs. Future work should augment this analysis with the uncountably many alternate explanations from competing frameworks of international political economy which might further refine and triangulate evidence regarding motivations on CBDC choice and timing. Furthermore, future work should explore the myriad alternate outcomes associated with central bank digital currencies; beyond timing, the design of CBDCs, cooperation among governments, and public-private partnerships stand as extremely salient intersections between CBDCs and international political economy. Finally, while this chapter has explored the motivations for CBDC timing with reference to private and decentralized digital currencies, the evidence that these non-fiat digital alternatives help to motivate quicker actions among governments strongly suggests a need for significantly greater academic attention - especially among international political economists - to private digital currencies and cryptocurrencies more generally.

These results also present clear policy implications. First, these results strongly suggest that CBDCs are here to stay. The evidence presented in this chapter show that few factors discourage CBDC among countries. While many countries exhibit low scores on the domestic variables which would predict a CBDC, the increasing number of countries in the world which pursue CBDC as a function of either push or pull factors implies a growing pressure on later movers through the pull factors identified in my theory and supported in these analyses. As such, while central banks may believe they have ample time to kick the can on this issue, these results suggest that central banks across the world would better spend their resources on precautionary policy and technical research to be prepared for any eventual need to issue a CBDC. Furthermore, as governments across the world increasingly pursue CBDCs, this has direct implications for market actors whose decentralized or private digital currencies serve similar roles in economies as fiat currency (V. K. Aggarwal and Marple 2020). More simply, the results presented here offer clues for a topography of market equilibria between government and alternate digital currencies premised on the timing of CBDC rollout.

As the status quo of government money changes, international political economy scholarship must rise to the challenge. The technical complexity of 21^{st} century money is an opportunity for the field of political economy, not a rationale to relegate this topic to computer science and economics. While developments change rapidly, and the technical details of CBDC remain significantly more complex than standard fiat money, it is eminently clear that the global politics of this economic issue fall squarely within our field of study. Despite the challenges of studying global politics in real-time, these results suggest that there is ample room for future work on the global politics of digital money. This chapter constitutes a first step in exploring this broad new topic area, and judging from the empirical support for the theory outlined here, it will be far from the last such exploration.

3.5 Appendix

Table 3.6: Differences in Main Variables Among CBDC and Non-CBDC Countries

Variable	Avg. CBDC (0)	Avg. CBDC (1)	Difference	Significant
GDP (USD)	23.082	25.174	2.092	1
Population	14.808	15.884	1.076	1
Inflation (GDP Deflator)	6.081	4.578	-1.503	0
Cellphone per capita	87.623	111.944	24.321	1
Gov. Effectiveness	-0.48	0.464	0.944	1
WIPO Index	90.08	50.367	-39.713	1
Fin. Dev. Index	0.189	0.438	0.249	1
Central Bank Independence	0.491	0.492	0.001	0
Broad Money to GDP	3.725	4.216	0.491	1
Financial Inclusion	35.885	66.517	30.632	1
Crypto ATM Count	0.418	1.541	1.123	1
Crypto Exchange: Count	0.036	0.356	0.32	1
Crypto Exchange: Volume	0.281	2.01	1.729	1
Orbis Network Centrality	0.169	0.386	0.217	1
Trade Subordinance	0.471	0.618	0.147	1
FDI Subordinance	0.128	0.284	0.156	1

Table 3.7: Rare Events Logistic Regression for Active First Mover CBDC Project

	Dependent Variable: Active First Mover (Binary)
GDP per capita	0.049***
	(0.008)
Inflation	0.001***
	(0.0001)
Cellphone per capita	0.00001
	(0.00005)
Gov. Effectiveness	0.003
	(0.004)
WIPO Index	−0.001***
	(0.0001)
Fin. Dev. Index	−0.177***
	(0.014)
Central Bank Independence	−0.012
	(0.012)
Orbis Network Centrality	0.027***
	(0.010)
Broad Money to GDP	0.007***
	(0.0004)
Financial Inclusion	−0.0003***
	(0.0001)
Crypto ATM Count	0.001
	(0.002)
Crypto Exchange: Count	0.026***
	(0.002)
Crypto Exchange: Volume	0.006***
	(0.001)
Trade Subordinance	0.049***
	(0.012)
FDI Subordinance	−0.040***
	(0.011)
Year	0.013***
	(0.001)
Constant	0.004
	(0.020)
Observations	16,898
R^2	0.176
Adjusted R^2	0.175
Residual Std. Error	0.219 (df = 16881)
F Statistic	225.539*** (df = 16; 16881)
Note:	*p<0.1; **p<0.05; ***p<0.01

Table 3.8: Fixed Effects OLS Regression for Active First Mover CBDC Project

	Dependent Variable: Active First Mover (Binary)			
	(1)	(2)	(3)	(4)
GDP per capita	5.061***	13.672***	14.329***	
	(0.659)	(1.487)	(1.349)	
Inflation	0.044***	0.043***	0.037***	
	(0.007)	(0.008)	(0.007)	
Cellphone per capita	−0.041***	0.014**	−0.070***	
	(0.004)	(0.006)	(0.008)	
Gov. Effectiveness	3.021***	−0.348	3.371***	
	(1.025)	(0.450)	(1.028)	
WIPO Index		−0.130***		
		(0.012)		
Fin. Dev. Index	18.572***	−18.076***	19.416***	
	(5.565)	(1.411)	(5.569)	
Central Bank Independence		−2.288*		
		(1.239)		
Orbis Network Centrality		3.761***		
		(0.999)		
Broad Money to GDP	0.183**	0.741***	0.185**	
	(0.076)	(0.044)	(0.076)	
Financial Inclusion	0.128***	−0.045***	0.052**	
	(0.023)	(0.010)	(0.025)	
Crypto ATM Count	1.242***	−0.053	0.991***	0.661***
	(0.148)	(0.162)	(0.160)	(0.184)
Crypto Exchange: Count	1.676***	2.625***	1.682***	−0.094
	(0.149)	(0.167)	(0.149)	(0.097)
Crypto Exchange: Volume	0.603***	0.526***	0.549***	0.124***
	(0.047)	(0.055)	(0.047)	(0.024)
Trade Subordinance	16.387***	3.808***	12.996***	
	(3.807)	(1.224)	(3.795)	
FDI Subordinance	2.503	−2.003*	5.027***	
	(1.640)	(1.153)	(1.779)	
Year	0.518***			
	(0.077)			
Country Fixed Effects?	Yes	No	Yes	No
Year Fixed Effects?	No	Yes	Yes	No
Country-Year Fixed Effects?	No	No	No	Yes
Observations	16,898	16,898	16,898	16,898
R^2	0.487	0.186	0.494	0.970
Adjusted R^2	0.484	0.185	0.491	0.967
Residual Std. Error	17.300 (df = 16783)	21.739 (df = 16869)	17.185 (df = 16771)	4.365 (df = 15479)

Note: *p<0.1; **p<0.05; ***p<0.01

Table 3.9: Fixed Effects OLS Regression for Active First Mover, Clustered S.E.

	Dependent Variable: Active First Mover (Binary)			
	(1)	(2)	(3)	(4)
GDP per capita	5.061	13.672*	14.329*	
	(3.500)	(8.159)	(7.384)	
Inflation	0.044	0.043	0.037	
	(0.047)	(0.044)	(0.042)	
Cellphone per capita	−0.041**	0.014	−0.070	
	(0.017)	(0.028)	(0.045)	
Gov. Effectiveness	3.021	−0.348	3.371	
	(8.649)	(2.798)	(8.763)	
WIPO Index		−0.130		
		(0.092)		
Fin. Dev. Index	18.572	−18.076*	19.416	
	(46.870)	(9.914)	(46.968)	
Central Bank Independence		−2.288		
		(10.159)		
Orbis Network Centrality		3.761		
		(7.427)		
Broad Money to GDP	0.183	0.741***	0.185	
	(0.273)	(0.173)	(0.269)	
Financial Inclusion	0.128	−0.045	0.052	
	(0.176)	(0.065)	(0.205)	
Crypto ATM Count	1.242	−0.053	0.991	0.661**
	(0.996)	(1.298)	(1.069)	(0.288)
Crypto Exchange: Count	1.676	2.625*	1.682	−0.094
	(1.228)	(1.377)	(1.216)	(0.079)
Crypto Exchange: Volume	0.603	0.526	0.549	0.124**
	(0.407)	(0.487)	(0.408)	(0.062)
Trade Subordinance	16.387	3.808	12.996	
	(24.907)	(14.887)	(24.964)	
FDI Subordinance	2.503	−2.003	5.027	
	(8.046)	(11.980)	(8.718)	
Year	0.518			
	(0.450)			
Country Fixed Effects?	Yes	No	Yes	No
Year Fixed Effects?	No	Yes	Yes	No
Country-Year Fixed Effects?	No	No	No	Yes
SE Clustering?	Country	Country	Country	Country
Observations	16,898	16,898	16,898	16,898
R^2	0.487	0.186	0.494	0.970
Adjusted R^2	0.484	0.185	0.491	0.967
Residual Std. Error	17.300 (df = 16783)	21.739 (df = 16869)	17.185 (df = 16771)	4.365 (df = 15479)

Note: *p<0.1; **p<0.05; ***p<0.01

Table 3.10: OLS Regression for CBDC Status Among CBDC-Pursuing Countries, HC1 S.E.

	Dependent Variable: Responder Project Progress (Value: 0-6)			
	(1)	(2)	(3)	(4)
GDP per capita	0.214**	0.114	0.120	0.161*
	(0.091)	(0.088)	(0.089)	(0.089)
Inflation	0.009***	0.008***	0.008***	0.006***
	(0.001)	(0.001)	(0.001)	(0.001)
Cellphone per capita	−0.006***	−0.005***	−0.005***	0.001**
	(0.0004)	(0.0004)	(0.0004)	(0.0004)
Gov. Effectiveness	0.045*	0.106***	0.105***	0.109***
	(0.028)	(0.023)	(0.023)	(0.022)
WIPO Index	−0.002***	−0.001*	−0.001*	0.001**
	(0.001)	(0.001)	(0.001)	(0.001)
Fin. Dev. Index	−0.111	−0.322***	−0.324***	−0.181
	(0.119)	(0.123)	(0.123)	(0.116)
Central Bank Independence	0.424***	0.512***	0.498***	0.201***
	(0.078)	(0.077)	(0.077)	(0.068)
Orbis Network Centrality	−0.006	0.084	0.093	0.089*
	(0.059)	(0.058)	(0.057)	(0.054)
Broad Money to GDP		0.003**	0.003*	0.005***
		(0.001)	(0.002)	(0.001)
Financial Inclusion		0.001*	0.001*	−0.001***
		(0.0004)	(0.0004)	(0.0004)
Crypto ATM Count		−0.077***	−0.077***	−0.036***
		(0.009)	(0.009)	(0.009)
Crypto Exchange: Count		0.020***	0.018**	0.006
		(0.007)	(0.007)	(0.007)
Crypto Exchange: Volume		0.029***	0.029***	0.026***
		(0.003)	(0.003)	(0.003)
Trade Subordinance			−0.068	−0.316***
			(0.062)	(0.058)
FDI Subordinance			−0.052	0.249***
			(0.059)	(0.054)
IGO Exposure				5.192***
				(1.312)
FDI Exposure				0.239
				(0.258)
Export Exposure				0.708***
				(0.260)
Sanctions Exposure				0.005
				(0.007)
Board Interlock Exposure				−1.622***
				(0.124)
Year	0.173***	0.174***	0.176***	0.033***
	(0.003)	(0.005)	(0.005)	(0.006)
Constant	−0.340**	−0.318**	−0.274*	−0.423***
	(0.158)	(0.148)	(0.150)	(0.151)
Observations	9519	9449	9449	9449

Note: *p<0.1; **p<0.05; ***p<0.01

Table 3.11: Ordinal Logistic Regression for Project Status Among CBDC-Pursuing Countries

	Dependent Variable: Responder Project Progress (Value: 0-6)
GDP per capita	0.752^{***}
	(0.165)
Inflation	0.009^{***}
	(0.002)
Cellphone per capita	0.004^{***}
	(0.001)
Gov. Effectiveness	0.198^{**}
	(0.095)
WIPO Index	-0.005^{*}
	(0.002)
Fin. Dev. Index	-0.543
	(0.360)
Central Bank Independence	0.132
	(0.233)
Orbis Network Centrality	0.761^{***}
	(0.192)
Broad Money to GDP	0.013^{**}
	(0.005)
Financial Inclusion	-0.007^{***}
	(0.002)
Crypto ATM Count	-0.060^{**}
	(0.025)
Crypto Exchange: Count	-0.023
	(0.015)
Crypto Exchange: Volume	0.042^{***}
	(0.005)
Trade Subordinance	-0.915^{***}
	(0.200)
FDI Subordinance	0.836^{***}
	(0.164)
IGO Exposure	-0.005
	(0.018)
FDI Exposure	1.049^{**}
	(0.471)
Export Exposure	0.878^{**}
	(0.432)
Sanctions Exposure	0.007
	(0.008)
Board Interlock Exposure	-2.412^{***}
	(0.204)
Year	0.892^{***}
	(0.059)
Observations	9,449
Note:	*p<0.1; **p<0.05; ***p<0.01

Table 3.12: OLS Regression Estimates for CBDC Project Status Among All Countries

	Dependent Variable: Responder Project Progress (Value: 0-6)			
	(1)	(2)	(3)	(4)
GDP per capita	0.020	−0.107***	−0.113***	−0.032
	(0.033)	(0.032)	(0.032)	(0.037)
Inflation	0.003***	0.003***	0.003***	0.002***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Cellphone per capita	−0.003***	−0.003***	−0.003***	−0.0001
	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Gov. Effectiveness	0.103***	0.197***	0.181***	0.150***
	(0.017)	(0.017)	(0.018)	(0.018)
WIPO Index	−0.005***	−0.002***	−0.002***	−0.0005
	(0.0005)	(0.0005)	(0.0005)	(0.0005)
Fin. Dev. Index	−0.385***	−0.475***	−0.383***	−0.308***
	(0.057)	(0.057)	(0.058)	(0.060)
Central Bank Independence	0.155***	0.269***	0.294***	0.290***
	(0.053)	(0.051)	(0.051)	(0.051)
Orbis Network Centrality	0.447***	0.308***	0.223***	0.226***
	(0.040)	(0.040)	(0.041)	(0.040)
Broad Money to GDP		0.004**	0.006***	0.009***
		(0.002)	(0.002)	(0.002)
Financial Inclusion		−0.002***	−0.002***	−0.003***
		(0.0004)	(0.0004)	(0.0004)
Crypto ATM Count		0.031***	0.024***	0.020***
		(0.006)	(0.006)	(0.006)
Crypto Exchange: Count		0.006	0.018**	0.013*
		(0.007)	(0.007)	(0.007)
Crypto Exchange: Volume		0.040***	0.041***	0.036***
		(0.002)	(0.002)	(0.002)
Trade Subordinance			0.398***	0.288***
			(0.050)	(0.050)
FDI Subordinance			0.059	0.154***
			(0.046)	(0.046)
IGO Exposure				2.628***
				(0.335)
FDI Exposure				0.169
				(0.135)
Export Exposure				0.226*
				(0.122)
Sanctions Exposure				−0.004
				(0.003)
Board Interlock Exposure				0.180***
				(0.047)
Year	0.097***	0.074***	0.072***	−0.004
	(0.002)	(0.003)	(0.003)	(0.004)
Constant	0.259***	0.333***	0.087	−0.129
	(0.078)	(0.076)	(0.082)	(0.086)
Observations	17,034	16,898	16,898	16,898
R^2	0.246	0.285	0.288	0.317
Adjusted R^2	0.245	0.284	0.287	0.316
Residual Std. Error	0.949 (df = 17024)	0.901 (df = 16883)	0.900 (df = 16881)	0.881 (df = 16876)
F Statistic	616.249*** (df = 9; 17024)	480.604*** (df = 14; 16883)	426.689*** (df = 16; 16881)	372.187*** (df = 21; 16876)
Note:				*p<0.1; **p<0.05; ***p<0.01

Table 3.13: Fixed Effect Variations for Status Among CBDC-Pursuing Countries

	Dependent Variable: Responder Project Progress (Value: 0-6)			
	(1)	(2)	(3)	(4)
GDP per capita	−0.076	0.452***	0.215**	
	(0.071)	(0.091)	(0.093)	
Inflation	0.003***	0.005***	0.002**	
	(0.001)	(0.001)	(0.001)	
Cellphone per capita	−0.004***	0.001***	−0.006***	
	(0.0004)	(0.0004)	(0.001)	
Gov. Effectiveness	0.162***	0.075***	0.169***	
	(0.063)	(0.027)	(0.063)	
WIPO Index		0.001*		
		(0.001)		
Fin. Dev. Index	1.559***	−0.160	1.738***	
	(0.322)	(0.112)	(0.323)	
Central Bank Independence		0.181***		
		(0.070)		
Orbis Network Centrality		0.129**		
		(0.054)		
Broad Money to GDP	0.001	0.006***	0.00001	
	(0.004)	(0.002)	(0.004)	
Financial Inclusion	0.019***	−0.002***	0.018***	
	(0.001)	(0.001)	(0.002)	
Crypto ATM Count	−0.046***	−0.048***	−0.064***	0.025*
	(0.009)	(0.010)	(0.010)	(0.015)
Crypto Exchange: Count	0.001	0.007	−0.0002	−0.005
	(0.007)	(0.007)	(0.007)	(0.007)
Crypto Exchange: Volume	0.026***	0.027***	0.027***	0.001
	(0.002)	(0.003)	(0.002)	(0.002)
Trade Subordinance	0.301	−0.346***	0.362	
	(0.242)	(0.063)	(0.244)	
FDI Subordinance	0.249***	0.303***	0.342***	
	(0.086)	(0.057)	(0.092)	
IGO Exposure	4.148***	5.519***	6.530***	−2.096*
	(0.922)	(1.189)	(1.072)	(1.154)
FDI Exposure	0.165	0.857***	0.255	−0.262***
	(0.159)	(0.268)	(0.222)	(0.092)
Export Exposure	1.001***	1.213***	0.589*	0.319**
	(0.148)	(0.370)	(0.306)	(0.126)
Sanctions Exposure	−0.004	−0.027***	−0.021***	0.037***
	(0.005)	(0.008)	(0.007)	(0.006)
Board Interlock Exposure	−0.824***	−1.683***	−0.938***	0.104
	(0.074)	(0.079)	(0.078)	(0.092)
Year	0.029***			
	(0.007)			
Country Fixed Effects?	Yes	No	Yes	No
Year Fixed Effects?	No	Yes	Yes	No
Country-Year Fixed Effects?	No	No	No	Yes
Observations	9,449	9,449	9,449	9,449
R^2	0.674	0.520	0.677	0.953
Adjusted R^2	0.671	0.518	0.674	0.949
Residual Std. Error	0.777 (df = 9374)	0.941 (df = 9415)	0.773 (df = 9362)	0.306 (df = 8649)
Note:				*p<0.1; **p<0.05; ***p<0.01

Table 3.14: Fixed Effect and S.E. Variations for Status Among CBDC-Pursuing Countries

	Dependent Variable: Responder Project Progress (Value: 0-6)			
	(1)	(2)	(3)	(4)
GDP per capita	−0.076	0.452	0.215	
	(0.293)	(0.436)	(0.466)	
Inflation	0.003	0.005	0.002	
	(0.003)	(0.004)	(0.004)	
Cellphone per capita	-0.004^{**}	0.001	-0.006^{**}	
	(0.002)	(0.002)	(0.003)	
Gov. Effectiveness	0.162	0.075	0.169	
	(0.523)	(0.143)	(0.525)	
WIPO Index		0.001		
		(0.005)		
Fin. Dev. Index	1.559	−0.160	1.738	
	(1.809)	(0.783)	(1.804)	
Central Bank Independence		0.181		
		(0.438)		
Orbis Network Centrality		0.129		
		(0.366)		
Broad Money to GDP	0.001	0.006	0.00001	
	(0.014)	(0.006)	(0.015)	
Financial Inclusion	0.019	−0.002	0.018	
	(0.012)	(0.003)	(0.013)	
Crypto ATM Count	−0.046	−0.048	−0.064	0.025
	(0.041)	(0.058)	(0.052)	(0.019)
Crypto Exchange: Count	0.001	0.007	−0.0002	−0.005
	(0.023)	(0.031)	(0.024)	(0.012)
Crypto Exchange: Volume	0.026^{**}	0.027^{*}	0.027^{**}	0.001
	(0.011)	(0.015)	(0.012)	(0.005)
Trade Subordinance	0.301	−0.346	0.362	
	(1.218)	(0.426)	(1.226)	
FDI Subordinance	0.249	0.303	0.342	
	(0.356)	(0.375)	(0.354)	
IGO Exposure	4.148	5.519	6.530	−2.096
	(5.619)	(9.849)	(7.840)	(2.932)
FDI Exposure	0.165	0.857	0.255	−0.262
	(0.446)	(0.668)	(0.502)	(0.204)
Export Exposure	1.001^{*}	1.213^{*}	0.589	0.319
	(0.544)	(0.681)	(0.550)	(0.328)
Sanctions Exposure	−0.004	−0.027	−0.021	0.037^{**}
	(0.027)	(0.054)	(0.042)	(0.016)
Board Interlock Exposure	−0.824	-1.683^{*}	−0.938	0.104
	(0.628)	(0.943)	(0.738)	(0.222)
Year	0.029			
	(0.038)			
Country Fixed Effects?	Yes	No	Yes	No
Year Fixed Effects?	No	Yes	Yes	No
Country-Year Fixed Effects?	No	No	No	Yes
SE Clustering?	Country	Country	Country	Country
Observations	9,449	9,449	9,449	9,449
R^2	0.674	0.520	0.677	0.953
Adjusted R^2	0.671	0.518	0.674	0.949
Residual Std. Error	0.777 (df = 9374)	0.941 (df = 9415)	0.773 (df = 9362)	0.306 (df = 8649)
Note:				*p<0.1; **p<0.05; ***p<0.01

Table 3.15: OLS Regression for Status Among CBDC-Pursuing Countries, Covid-19 Controls

	Dependent Variable: Responder Project Progress (Value: 0-6)	
	(1)	(2)
GDP per capita	0.001	-0.337^{***}
	(0.037)	(0.102)
Inflation	0.002^{***}	0.002^{**}
	(0.0003)	(0.001)
Cellphone per capita	0.0004	-0.001
	(0.0002)	(0.001)
Gov. Effectiveness	0.144^{***}	0.753^{***}
	(0.018)	(0.087)
WIPO Index	-0.0004	-0.002
	(0.0005)	(0.002)
Fin. Dev. Index	-0.344^{***}	-1.595^{***}
	(0.060)	(0.334)
Central Bank Independence	0.274^{***}	0.179
	(0.051)	(0.218)
Orbis Network Centrality	0.225^{***}	1.418^{***}
	(0.040)	(0.215)
Broad Money to GDP	0.009^{***}	0.004
	(0.002)	(0.007)
Financial Inclusion	-0.003^{***}	-0.013^{***}
	(0.0004)	(0.002)
Crypto ATM Count	0.024^{***}	0.037
	(0.006)	(0.026)
Crypto Exchange: Count	0.014^{**}	-0.040^{**}
	(0.007)	(0.018)
Crypto Exchange: Volume	0.037^{***}	0.061^{***}
	(0.002)	(0.006)
Trade Subordinance	0.280^{***}	1.144^{***}
	(0.050)	(0.235)
FDI Subordinance	0.144^{***}	0.719^{***}
	(0.046)	(0.183)
IGO Exposure	2.360^{***}	-1.825^{*}
	(0.337)	(0.935)
FDI Exposure	0.408^{***}	2.514^{***}
	(0.139)	(0.593)
Export Exposure	0.379^{***}	3.363^{***}
	(0.124)	(0.926)
Sanctions Exposure	-0.009^{***}	-0.028^{**}
	(0.003)	(0.012)
Board Interlock Exposure	0.195^{***}	-0.531^{***}
	(0.047)	(0.138)
Covid Year	0.303^{***}	
	(0.044)	
Covid Cases per capita		-0.0001
		(0.0001)
Year	0.0003	0.180
	(0.005)	(0.133)
Constant	-0.221^{**}	-1.547
	(0.087)	(1.594)
Observations	16,898	2,309
R^2	0.318	0.266
Adjusted R^2	0.318	0.259
Residual Std. Error	0.880 (df = 16875)	1.382 (df = 2286)
F Statistic	358.427^{***} (df = 22; 16875)	37.683^{***} (df = 22; 2286)
Note:		*p<0.1; **p<0.05; ***p<0.01

Table 3.16: OLS Regression for Status Among CBDC Countries, Chinese Peer Effects

	Dependent Variable: Responder Project Progress (Value: 0-6)	
	(1)	(2)
GDP per capita	0.163**	0.225***
	(0.071)	(0.071)
Inflation	0.006***	0.006***
	(0.001)	(0.001)
Cellphone per capita	0.001***	0.002***
	(0.0003)	(0.0003)
Gov. Effectiveness	0.168***	0.156***
	(0.026)	(0.026)
WIPO Index	0.003***	0.003***
	(0.001)	(0.001)
Fin. Dev. Index	−0.090	−0.096
	(0.111)	(0.111)
Central Bank Independence	0.227***	0.215***
	(0.069)	(0.069)
Orbis Network Centrality	0.082	0.096*
	(0.054)	(0.053)
Broad Money to GDP	0.009***	0.009***
	(0.002)	(0.002)
Financial Inclusion	−0.002***	−0.002***
	(0.001)	(0.001)
Crypto ATM Count	−0.027***	−0.027***
	(0.009)	(0.009)
Crypto Exchange: Count	−0.004	−0.004
	(0.008)	(0.008)
Crypto Exchange: Volume	0.024***	0.023***
	(0.003)	(0.003)
Trade Subordinance	0.319***	0.292***
	(0.073)	(0.073)
FDI Subordinance	−0.160***	−0.130**
	(0.060)	(0.060)
IGO Exposure	5.387***	5.775***
	(1.000)	(0.997)
FDI Exposure	0.249	0.465**
	(0.191)	(0.191)
Export Exposure	0.932***	0.961***
	(0.191)	(0.190)
Sanctions Exposure	0.001	−0.029***
	(0.006)	(0.007)
Board Interlock Exposure	−1.589***	−1.611***
	(0.076)	(0.076)
China's Status	0.056***	0.096***
	(0.022)	(0.022)
Global Average Status		0.830***
		(0.092)
Year	0.020**	−0.005
	(0.008)	(0.009)
Constant	−0.943***	−1.026***
	(0.146)	(0.146)
Observations	9,282	9,282
R^2	0.513	0.517
Adjusted R^2	0.512	0.516
Residual Std. Error	0.933 (df = 9259)	0.929 (df = 9258)
F Statistic	443.272*** (df = 22; 9259)	431.228*** (df = 23; 9258)
Note:		*p<0.1; **p<0.05; ***p<0.01

Table 3.17: Survival Model for First Signal Among CBDC-Pursuing Countries, No Clustering

	Dependent Variable: Survival to First Action	
	(1)	(2)
Central Bank Independence	1.246	0.103
	(1.209)	(0.973)
Orbis Network Centrality	1.589*	−0.456
	(0.904)	(0.830)
Broad Money to GDP	−0.010	−0.011
	(0.033)	(0.022)
Financial Inclusion	−0.010	−0.006
	(0.009)	(0.007)
Crypto ATM Count	0.012	0.222**
	(0.135)	(0.109)
Crypto Exchange: Count	0.062	−0.035
	(0.168)	(0.077)
Crypto Exchange: Volume	0.057*	0.016
	(0.039)	(0.025)
Trade Subordinance	−1.754	−1.673**
	(1.363)	(0.878)
FDI Subordinance	2.280**	2.110***
	(0.992)	(0.833)
Responder	−7.244***	−0.168
	(2.426)	(0.403)
IGO Exposure	−55.468**	−42.690*
	(27.847)	(22.117)
FDI Exposure	−6.289	−62.076
	(60.579)	(63.932)
Export Exposure	65.341***	29.345**
	(27.557)	(18.810)
Sanctions Exposure	−3.969***	−1.473***
	(1.020)	(0.488)
Board Interlock Exposure	1.203	0.560
	(1.902)	(1.250)
Event Type	First Signal	First Response
Observations	3,930	4,625
R^2	0.026	0.007
Max. Possible R^2	0.080	0.089
Log Likelihood	−111.536	−199.492
Wald Test (df = 15)	62.210***	56.460***
LR Test (df = 15)	105.012***	33.510***
Score (Logrank) Test (df = 15)	221.572***	37.300***

Note: *p<0.1; **p<0.05; ***p<0.01

Table 3.18: Cluster Membership from Project Sequence Analysis

Cluster 1	Cluster 2
Bahamas	Argentina
Bahrain	Australia
Belarus	Brazil
Bermuda	Cape Verde
Cambodia	Chile
Canada	Colombia
China	Czechia
Curaçao	Georgia
Denmark	Haiti
Ecuador	India
Egypt	Jamaica
El Salvador	Japan
Eswatini	Kazakhstan
Ghana	Kenya
Hong Kong	Kuwait
Iceland	Madagascar
Indonesia	Marshall Islands
Iran	Mauritius
Israel	Micronesia
Lebanon	Morocco
Malaysia	Mozambique
Mexico	Nigeria
New Zealand	North Korea
Norway	Pakistan
Rwanda	Palau
Senegal	Palestine
Singapore	Peru
South Africa	Philippines
Sweden	Russia
Thailand	South Korea
Tunisia	Switzerland
Turkey	Taiwan
Ukraine	Tanzania
United Arab Emirates	Trinidad & Tobago
United Kingdom	Vietnam
United States	-
Uruguay	-
Venezuela	-

Figure 3.4: CBDC Signal Sequences, Sorted by Distance to First LCS Factor

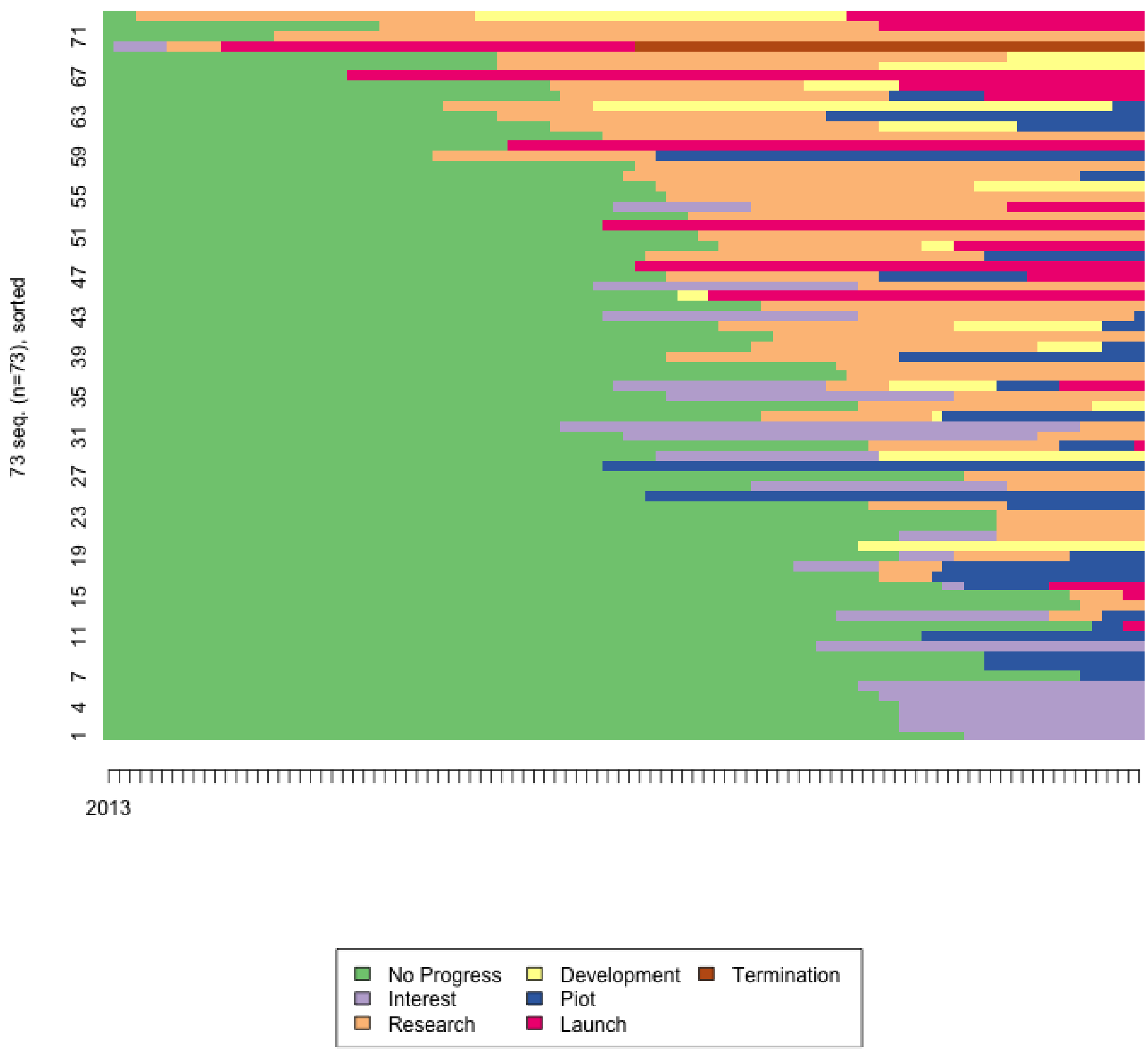


Figure 3.5: CBDC Signal Sequences, Sorted by Distance to Most Common LCS Factor

CBDC Progress Data Codebook

This codebook provides instructions for our final coding. Our coding measures four dimensions of CBDC reports: (1) stage of digital currency projects, (2) news about projects independent of the stage of development, (3) motivation for digital currency projects, and (4) valence of the report. In the following sections, this document defines what each of those dimensions is in greater detail and then explains the code values which can be included in that dimension of coding for each row.

i. General Instructions

- Verifying text content:
  - Review the text content in each row before any coding. If the content appears incomplete or not self-contained, please refer to the data source indicated in the first row of the entry to identify the full text and update it accordingly. See the following key for source codes from the data file and corresponding report sources: Belfer Center, CoinMarket Cap collection, Medium Article Collection, OMFIF CBDC Tracker, and collected government and IGO reports.
- Verifying entered dates:
  - Review the text entered in the third column of a row, and ensure that the Month in row E and Year in row F correspond to the date reported in the text. Please see the next step if the Month and/or Year are not reported in the text. If Months are entered as text, please correct to numeric (e.g. 9, not "September").
- Verifying entered dates:
  - Search online for the Month and/or Year of the reported text if the Month and/or Year are not included in the text from the report used to build our data.
  - If the Month and/or Year are completed using a source other than the Text in column C, please report the link(s) where the additional date information was located in column G for that row, "Date Link Extra".
  - If the month is missing for an entry, code '1' in the 'Missing Date' column.
  - If the date is derived from a third party, and does not have a specific date associated with the report, code a '1' in the 'Speculative Date' column.
- Identifying duplicate entries:
  - Where an entry appears to be a duplicate from a proximate entry, please enter a unique letter in "Potential Duplicate" for each country-row with duplicate content. Please enter the letter 'A' for the row among duplicates which has the most information, and the letter 'B' for other duplicate rows with less information. When the information is comparable, select the 'A' row arbitrarily.

  - Please enter a value of '1' in the "Conflict Duplicate" column if the duplicate rows you identified with the 'A' and 'B' strategy include inconsistent information (e.g. they have different values in the "Valence" column, for example).

- Separating rows about payment systems:
  - Enter a value of '1' in the "Payment System" column when the text in a row refers to development of a payment system rather than the digital currency itself.

ii. Stage of Project

This dimension includes code values which indicate the stage of the central bank digital currency project in a country. By stage of project, we here refer to the sequence of generalizable activities which are associated with digital money projects across countries. We have two kinds of code for this dimension. The first code is major stage of project, which describes the position of the project in one of 6 major stages: interest, research, development, pilot, launch, and termination. Each major stage includes minor stages which characterize specific actions in each stage.

Because a row may include information on multiple stages, we have one column for each major stage. If the content in a row indicates information about a given major stage, we will enter the code for the relevant minor stage in the column for that row. For example, if a row includes some information on the announcement of a project where no research or development has yet begun in that country, we would enter "Announce project" in the "Stage Interest" column for that row.

These major stages are defined below with minor stages in sub-bullets for each major stage:

- Interest: the government or central bank has indicated an interest in sovereign digital currencies. This may be an interest in pursuing a domestic project, or any explicit discussion of sovereign digital currencies by a central bank or government official in the dataset. References to cryptocurrencies or other private digital currencies do not qualify.
  - Initial discussion: The government first shows interest in or explicitly mentions CBDC. Mentioning preconditions or predecessors of CBDC but not directly referring to CBDC itself does not count.
  - Announce interest: Further expression of interest in CBDC after the initial discussion and before substantive research.
  - Announce project: The government organizes a team or center dedicated to CBDCs, and publicly announces they have initiated a project dedicated to CBDC.
- Research: the government or central bank has begun formal research on digital currencies for their country. This is distinct from interest in that government actors have

signaled the onset of specific and targeted investigation of digital currencies. The focus of research may vary substantially, but the research must be conducted by a team organized, overseen, or requested by government actors. This does not include research which is dedicated to the development of an actual digital currency pilot used by wider audiences.

- Announce research: The government builds and introduces a research team (before beginning work on research), announce the expected date of research results, plans, or objectives of an upcoming research.
- Research feasibility: The government begins research focused on whether or not to develop the CBDC. Usually includes a discussion on the feasibility, implications, benefits and risks, impact on existing system, etc. from a digital currency.
- Research design: The government begins research on different frameworks for a CBDC. Usually includes a discussion on choosing the optimal model/design. Salient design themes include general-purpose, wholesale, retail, etc.
- Research application: The government begins research dedicated to the know-how of specific CBDC functions or solution to problems exposed in tests. An example might include simulations or testing viability of prototype – not an actual pilot.

- Development: the government has begun to build a pilot of their digital currency. This is different from research in that government actors have settled on the decision to pursue a digital currency and are engaged in the design and experimentation necessary for a pilot. This stage includes discussion on the technical features of a pending CBDC for a country.

  - Announce development: The government announces that work has begun to develop a digital currency prototype and pilot. This can include information about expected date of development completion, objectives of the development, or other aspects of the project specific to the newly announced CBDC.
  - Announce design feature: The government announces specific features of the CBDC project they are working on. This can include details about whether the CBDC is retail or wholesale, domestic or international, etc.
  - Announce interoperability: The government announces that the digital currency will be available to use in some pre-existing commercial or financial platform. For example, if the CBDC is enabled on mobile apps or online financial services.

- Pilot: the government is testing a pilot prototype of their digital currency with actual firms and consumers. This is different from development, wherein government actors may conduct limited tests of viability or simulations to assess design features – in the pilot stage, a self-contained CBDC prototype is already built and being test-run with citizens of a country, actual banks (plural), or actual companies in a country.

  - Announce pilot: the government announces that a pilot project is ready to launch, and includes some details about where it is being tested and with what actors. The pilot must be imminent, not active, by time of announcement for this code.
  - Begin pilot: the government announces that a pilot of the CBDC has begun already and describes the nature of the pilot testing already underway. The pilot must be active by time of announcement for this code.
  - Expand pilot: the government announces that the pilot project is expanding beyond its original charge. Examples include adding new groups of consumers, companies, or banks who are involved in the pilot testing process, or new functionalities in test.
  - Evaluate outcomes: the government announces that they are evaluating outcomes or announces an evaluation of the outcomes from the pilot project.
  - Conclude pilot: the government announces that the pilot project is complete and no further pilot testing will occur.

- Launch: the government has launched the CBDC for widespread use in the country. This is different from the pilot stage in that government actors have now certified that the pilot stage is over and the digital currency is free for use in most or all commercial and/or financial forums of exchange. Where the pilot stage has limited (positive) use cases in the real economy, the launch stage has only limited instances where it cannot be used, if at all.

  - Announce issuance: the government announces that a final CBDC is ready to launch, and includes some details about how it is being launched, where it is usable, etc. Launch must be imminent, not active, by time of announcement for this code.
  - Begin issuance: the government announces that the CBDC is already live and describes the nature of how citizens and companies can engage with the CBDC. The final CBDC must be active by time of announcement for this code.
  - Expand issuance: the government announces that the CBDC is expanding. Examples include adding new groups of consumers, companies, or banks who are eligible to use or receive the CBDC, or new functionalities of the live CBDC.
  - Evaluate outcomes: the government announces that they are evaluating outcomes or announces an evaluation of the outcomes from the launch of the final CBDC.

- Termination: the government has announced the digital currency project is being ended. This requires a formal statement that the CBDC project will not continue past its current stage, regardless of the stage at which termination is announced.

  - Announce termination: the government announces that research teams, development projects, or systems related to the CBDC will be taken down.

  - Complete termination: the government announces that any research teams, development projects, or systems related to the CBDC have been taken down and are no longer operational.

iii. Stage-Independent Developments

We are also interested in collecting information about these projects which is independent of the stages of the digital currency project described above. This includes announcements which pertain to: (1) the rate of progress in the project, (2) private partnerships associated with the project, (3) regulations on digital currencies, or (4) interstate cooperation on the digital currency project. Each of these has its own column and the coding protocol for each is described below:

- Target Month: we enter the target Month if the announcement indicates an anticipated date for any stage of the project which is planned to be reached at a date after the announcement.
- Target Year: we enter the target Year if the announcement indicates an anticipated date for any stage of the project which is planned to be reached at a date after the announcement.
- Private Partnership: this column remains empty unless a row indicates that the government is establishing a partnership with a private company. In this case, we enter the name of the company or companies cited in that text in this column for that row. This includes all partnerships with non-state entities. Separate multiple entries in a row with commas.
- Regulations: we code a 1 in this column if the entry in that row discusses any regulations around the CBDC project OR regulations around cryptocurrencies or other digital money.
- Noncommittal: we code a 1 in this column if the entry in that row explicitly refuses to commit to launching a CBDC or proceeding with development. Examples include language by Canada or Tunisia in denying reports or characterizing efforts as only precautionary.
- Interstate Cooperation: this column remains empty unless a row indicates that the government is cooperating, sharing information, or creating a partnership with another government. In this case, we enter the name of the government or governments cited in that text in this column for that row. Only countries qualify for this row. Separate multiple entries in a row with commas.

iv. Motivation for Project

Beyond the major and minor stage of projects, we are interested in knowing the motivations that governments and central bankers cite for their digital currency project. Because motivations for projects are only expressed at some stages, and this varies by country, we want to capture motivations cited within updates to the stage of the digital currency project. There are 8 motivations we can code, which each have their own column in the coding file. The following bullets indicate when to code a value of 1 in each column for a given row:

- Financial inclusion: the government cites issues of underbanking or unbanked citizens, and extending access to banking, as a rationale for the digital currency project.
- Declining cash use: the government cites the declining use of cash within its domestic economy as a rationale for the digital currency project.
- Banking efficiency (domestic): the government cites issues of domestic banking efficiency (e.g. interbank clearance within the country) as a rationale for the digital currency project.
- Cross-border payments (international): the government cites issues of international banking efficiency, namely cross-border payment clearance, as a rationale for the project.
- Sanctions: the government cites the domestic economic effect of sanctions, or the desire to subvert or undermine sanctions, as a rationale for the digital currency project.
- Precautionary: the government characterizes the digital currency project as a "just in case" measure, contingent on other factors changing within or outside the economy (e.g. other CBDCs emerge, cash use declines further, etc.)
- Transparency: the government characterizes the digital currency project as promoting transparency in state spending, as a fraud mitigation measure, or other similar mechanisms.
- Financial Stability: the government characterizes the digital currency project as promoting financial stability in the economy or addressing issues of financial instability in the country. We do not code this if the financial stability is expressed as a concern of pursuing CBDC.
- Other: motivations cited by government which are not captured by any of the codes above. (Include a description for this in the Motivation Notes column if you use this code.)

v. Valence of Content

Finally, we are interested in knowing the valence of content in each of our observations. By valence, we refer to whether the news about the project is positive, neutral, or negative. By default, we treat all news in the dataset as neutral unless it exhibits a positive or negative valence. In the "Valence" column, we code "Positive" if the content in that row reports encouragement of the digital currency project, or of digital currency projects in general. We code "Negative" if the content in that row includes claims against the viability, suitability, legitimacy of CBDC projects. We leave this column blank if there is no recognizable positive or negative valence in a row.

Chapter 4

In Code We Trust

4.1 Introduction: Upgrading Fiat Money

Why are central bank digital currencies designed more or less radically across the world, and why are projects more or less similar across borders? As governments race to research and design central bank digital currencies (CBDCs), they face uniquely wide choice menus in the mechanics of how money *works* in society, and unique vectors of pressure from governments and private actors. Unlike status quo decisions central banks face around money, such as fund rates and implications of asset purchase programs, design features of CBDCs have the potential to radically reshape the social structures of government money both within and across sovereign borders. In this respect, how countries proceed with upgrading fiat money through CBDC design constitutes one of the most significant policy choices and coordination problems of the century in the global regime for government currency.

Despite the magnitude of this policy choice and coordination problem, there has been extremely limited academic research on the global politics of designing CBDCs. Most existing scholarship has focused exclusively on the economics and politics of decentralized and private digital currencies, with extremely little attention to the causes and consequences of governments' projects in this space (Campbell-Verduyn 2017; Lyons and Viswanath-Natraj 2020; Parkin 2019). While chapter 1 examined the role of CBDCs in the broader ecosystem of digital money, and chapter 3 explored the strategic causes of variation in project timing among countries, the larger question of how these new currencies are *designed* has been left unanswered in the field of international political economy. Long-standing scholarship on both state-level pressures in fiat money, such as internationalizing a currency (Strange 1971; Seabrooke 2001), paired with accounts of how countries managed comparable collective actions problem in designing the Bretton Woods system (Eichengreen 2011), strongly suggest that the design of CBDCs remains a critical area of research for practitioners of political science and international political economy.

Building on existing work, and as I explored initially in chapter 2, I argue that two outcomes are especially important to political economists in the scope of CBDC designs: departure from status quo, and pairwise similarity among projects. First, it matters whether CBDC projects vary substantively from the current status quo of how government money operates because this stands to disrupt the network of dense economic exchange among countries. These spillover effects trigger countries' sensitivity to their interdependence, politically and economically, with other countries through CBDC designs, and by extension, stand as important international pressures facing decision-makers. Second, and relatedly, the network of pairwise similarity among CBDC projects in the world matters because of the coalitions it implies in the emerging debate on soft and technical standards for digital government money. In tandem, moving beyond the domestic drivers and consequences of CBDC design choices, I argue that these international factors stand as theoretically critical factors in the global politics of updating fiat currency.

The chapter proceeds in the following sections. First, I describe the new and expanded dataset I use to test these theoretical expectations, built both from work on CBDC project timing in the preceding chapter, and expanded with coded data that follows the specifications for CBDC design established by the Bank for International Settlements (BIS) (R. Auer and Böhme 2020). The following section discusses the results from two empirical tests of this theory, respectively regarding state-level variation in how radical or status quo CBDC designs are, and variation in pairwise similarity among CBDC projects. The results offer support for my theoretical expectations and imply several specific lines of future research, which I discuss alongside policy implications in the conclusion.

4.2 Data: Structure and Contents

In this section, I briefly explain the primary empirical data used to adjudicate on my theoretical expectations regarding state- and dyadic-level outcomes in CBDC project designs. I first explore the primary dependent variable used in the tests of my theory, which measures design choices among CBDC projects at the state and dyad levels based on an expanded collection of reports hosted by the BIS (R. A. Auer, Cornelli, and Frost 2020). I then describe the primary independent variables used in the statistical tests, derived primarily from the existing data collection used in the previous chapter's analysis on CBDC project timing and strategic interaction. I then conclude with a brief discussion of necessary control variables drawn from traditional datasets in the fields of political science and economics.

i. Dependent Variables: CBDC Design Choices

As explored in the first chapter, the choice menu available to central bank decision-makers in digital money is uniquely wide and involves a much broader set of actors than previous instances of monetary politics. In the context of how CBDC projects progress over time, there is strong evidence that not only are standard interstate pressures salient motivations of CBDC timing, but also that new causal factors inherent to the digital economy, such as cryptocurrency use, are important explanatory factors which cannot be omitted from research on the global politics of CBDCs. Specifically, this requires attention to the three primary design features of CBDCs which stand to challenge the status quo of government money through their uniquely wide menu of technical options. These include: architecture, infrastructure, and access. I briefly define each feature here in accordance with its description in existing economics research (R. Auer and Böhme 2020), and summarize potential outcomes of each feature in table 4.1 with regard to the degree of similarity to or difference from today's fiat money along each dimension.

Table 4.1: CBDC Design Features and Technical Options

Design Feature	***Status Quo***	***Moderately Different***	***Radically Different***
Architecture	Indirect Claims	Hybrid Architecture	Direct Claims
Infrastructure	Conventional Ledger	Hybrid Infrastructure	Distributed Ledger
Access	Account Access	Hybrid Access	Token Access

Architecture determines the role a central bank will take in managing claims made via a retail CBDC. Today, most currencies operate on an infrastructure of intermediated claims, wherein central banks maintain a ledger of wholesale transactions with private banks, who bear the responsibility of managing and overseeing retail ledgers with consumers and firms. This is known as the "two-tiered" framework for banking architecture and provides important benefits to both governments and private banks. The current menu of design choices on the dimension of CBDC architecture include indirect, with money being a claim on an intermediary, direct, with money being a direct claim on the central bank, or a hybrid model which includes elements of each extreme. Whereas the indirect menu option serves as the digital analog of existing two-tiered currency architecture, the hybrid and direct frameworks are more radical design choices given their implications for the political economy of retail banking and social relations among actors in the financial economy.

Infrastructure refers to how retail CBDC supply is managed and overseen. This specifically refers to the nature of the ledger system which organizes currency supply and movement across actors. Today, most currencies have a centralized infrastructure, whereby the central bank maintains a ledger of all wholesale currency transactions. While this affords the benefits of coordinated ledger maintenance and hierarchy of control, cryptocurrencies like Bitcoin have offered compelling use cases to central banks for more decentralized ledger solutions. Specifically, some central banks are entertaining the same distributed ledger technology (DLT) used by Bitcoin and other cryptocurrencies, blockchain, as the infrastructure of their digital currency projects. This not only represents a radical departure from standard auditing technology and currency oversight; it also produces important changes in government transparency and macroeconomic monetary policy, for example. As such, whereas the centralized ledger approach is the more traditional design option, the hybrid and decentralized models serve as more radical design choices among government digital currencies.

Access refers to how end-users acquire and use a retail CBDC. On one hand, a digital currency can be accessed in an account framework, whereby an end-user's identity serves as mechanism for CBDC access. On the other hand, digital currencies can rely on token frameworks, which use typically encryopted peer-to-peer transaction methods as the access mechanism. More simply summarized by the Bank for International Settlements, this is the difference between "I am, therefore I own" (account), and "I know, therefore I own" (token) (R. Auer and Böhme 2020). This is another example where a technical feature spells either continuity or disruption for existing social structures in the global economy. Whereas our current system of retail currency transactions privileges private banks by granting them the authority of identity verification, per the two-tiered architecture of claims, a token framework would dissolve this privilege by removing intermediary benefits to transactions. More simply, whereas an account framework is a status quo design choice available to policy makers in digital currencies, hybrid and token frameworks are respectively more radical design choices.

The two primary outcome variables in the following tests are coded in line with the BIS framework for CBDC designs explained above.[1] The data were collected first with reference to all existing reports in existing repositories like those hosted by the BIS, and extended with a search for all government announcements regarding their respective CBDC projects. All announcements were coded along the three-class framework for each design feature above, and coded numerically with a value of 0 for status quo, 1 for hybrid, and 2 for most radical choices. The main outcome variable in the first models below is the average score for all choices made by a given country at a point in time (the sum of all scores divided by the number of design features announced). In the case of pairwise similarity, each design feature for which both countries have announced a decision by given time takes a value of 2 if it is identical, a value of 1 if one is hybrid and the other is not, and a value of 0 if neither is hybrid and both choices are different. This reflects the general interoperability scale outlined in existing work, allowing for partial values assigned to partially interoperable choices (R. Auer and Böhme 2020). The main outcome variable in the second set of models is the total pairwise score across all design features for an observed pair of states at a unit in time, limited only to pairs of states which ever mutually announced atleast one design feature.

ii. Independent Variables: Push & Pull Factors

The primary independent variables in this chapter measure push and pull factors facing countries at the domestic and international levels in the context of CBDC development, described at length in the preceding chapter and summarized here with regard to the source of empirical data and transformations made before analysis in the following statistical models.

[1] These design features pertain only to retail CBDC projects which interface with firms and consumers, and are not applicable to wholesale projects (R. A. Auer, Cornelli, and Frost 2020). While all retail projects have a wholesale component by design, not all wholesale projects have a retail component. For this reason, and because CBDC projects without a retail component fall outside the scope of the proposed theoretical framework, wholesale-only CBDC projects were not coded or included in this analysis.

The primary measures of theoretical push factors facing countries in CBDC development include currency in circulation, rate of financial inclusion, counts of cryptocurrency ATMs, counts of and volume on cryptocurrency exchanges, centrality in global networks of corporate banking boards, and subordinance in global networks of interstate trade and investment. Currency in circulation, which is known for its difficulty of measurement outside of only the most developed countries in the world (Khiaonarong and Humphrey 2019), is proxied with country-year measures of broad money in circulation, normalized by GDP, in line with best practices outlined in existing work. The number of cryptocurrency ATMs is drawn from CoinMap's API (*CoinMap Cryptocurrency ATM API* 2021), measured as the cumulative counts of ATMs at a country-month. Cryptocurrency exchange count and volume are aggregated at the country-month level, provided by CryptoCompare, the largest public repository of crypto-exchange data in the world (*CryptoCompare* 2021).

Centrality in the global network of corporate banking boards is estimated using a social network model based on Orbis data of all corporate boards for all active banks in every country with revenue above $25million (*Orbis Corporate Board Data* 2021). Following best practices applied widely in American and international political economy to measure relational phenomena on large-N corporate board data using network analysis, (Marple, B. Desmarais, and K. L. Young 2017; Marple 2020; K. L. Young, Marple, and Heilman 2017), I build a social network of countries connected by the number of shared board members across their respective domestic banks. I estimate centrality as the normalized degree centrality of each country, or simply the proportion of all possible ties to other countries that each country has in the network, a simple and popular measure of centrality (Jackson 2005).

Subordinance in global networks of foreign trade and investment are also estimated as network measures, as in chapter 3. I construct these subordinance variables for each country-year, first by building a network of trade and investment with IMF direction of trade data (*IMF Direction of Trade Statistics* 2021) and outward FDI data (*IMF Outward FDI Statistics* 2021). I then estimate two centrality measures for each country in each year's network: (i) normalized degree centrality and (ii) eigenvector centrality. Normalized degree centrality is again the proportion of all possible ties held by each country, while eigenvector centrality weights this estimate by the popularity of each country's neighbors in the network (Wasserman, Faust, et al. 1994). A positive value on this difference indicates countries subordinate to their neighbors in either network, which corresponds to theoretical expectations in long-standing sociological scholarship on status inconsistency in social networks and implications for actor preferences on status quo rules and standards (Stryker and Macke 1978; Askin and Bothner 2012; Jensen and P. Wang 2018).

The primary pull factor measures to test theoretical expectations of exposure include five measures of interstate exposure: intergovernmental organizations, investment, trade, sanctions, and banking board interlocks. Each measure is derived from relational data, respectively capturing outward FDI (*IMF Outward FDI Statistics* 2021), directed trade (*IMF Direction of Trade Statistics* 2021), co-membership in IGOs (Pevehouse et al. 2020), interstate alliances (Gibler 2008), and directed sanctions (Felbermayr et al. 2021). For trade and FDI exposure, measures are estimated as the total share of economic exchange among top

5 partners for each country, normalized at the dyad level. IGO co-membership is measured as the share of country A's IGO affiliations shared by country B, and vice versa, averaged at the dyad level. Alliances and sanctions are measured as a binary indicator for whether a pair of countries either has any alliance relationship, or has experienced a sanctions relationship in years preceding the dyad-year observation, respectively.

iii. Control Variables: Permissive Factors

Finally, control variables that measure permissive factors in the theoretical framework include GDP, population, inflation, cellphone subscriptions per capita, government effectiveness, technology sector competitiveness, financial development, and central bank independence (CBI), in line with variables tested in other early work on this issue (R. A. Auer, Cornelli, and Frost 2020). GDP, population estimates, GDP deflator inflation, and per capita cell-phone subscription measures were accessed from the World Bank, measured at a country-year level. Government effectiveness is estimated from a World Bank survey and reported on a yearly basis with the most recent score to each panel of survey data by country. Technology sector competitiveness is measured with the WIPO global ranking of technical competitiveness, reported at a country-year basis (WIPO 2020). Financial development is drawn from the IMF estimation widely used in political economy research (Svirydzenka 2016), and CBI draws on the dataset with the broadest, most recent coverage (Garriga 2016).

4.3 Empirical Results

i. Why do countries choose more (or less) radical CBDC designs?

Whereas some CBDC projects closely resemble the status quo of fiat currencies, others implement significantly more radical design choices that stand to fundamentally reshape domestic and international relations around money. As I explored in the theoretical framework presented earlier, countries make these choices about how status quo or radical their CBDC design features are in the context of on-going global economic exchange. Per long-standing theoretical traditions in international political economy, and early evidence on the implications for CBDC project timing, we should expect subordinance in global trade and investment networks to motivate more radical projects among countries. As I show in table 4.2, these expectations see strong support in the data. Notably, every 1 unit shift in trade subordinance is associated with about 0.18 higher points in CBDC radical scores, and every 1 unit shift in FDI subordinance is associated with approximately 0.22 higher points.

As I show in the appendix, these results are consistent under a variety of alternate model specifications. Table 4.5 shows these results are consistent and remain significant when specified with HC1 standard errors. Similarly, as I show in table 4.6, all controls remain consistent and results for trade subordinance are consistent and remain significant with a variety of fixed effects specifications at the country and year level, while FDI subordinance

Table 4.2: OLS for Average Radical Score by CBDC Project

	Dependent Variable: CBDC Project Radical Score (Average)		
	(1)	(2)	(3)
GDP per capita	0.297***	0.288***	0.271***
	(0.030)	(0.030)	(0.030)
Inflation	0.005***	0.005***	0.005***
	(0.0003)	(0.0003)	(0.0003)
Cellphone per capita	−0.001***	−0.001***	−0.001***
	(0.0001)	(0.0001)	(0.0001)
Gov. Effectiveness	0.040***	0.064***	0.077***
	(0.011)	(0.012)	(0.012)
WIPO Index	−0.002***	−0.002***	−0.001***
	(0.0003)	(0.0003)	(0.0003)
Fin. Dev. Index	−0.322***	−0.314***	−0.312***
	(0.047)	(0.052)	(0.051)
Central Bank Independence	−0.410***	−0.413***	−0.364***
	(0.031)	(0.032)	(0.032)
Orbis Network Centrality	0.104***	0.062**	0.037
	(0.023)	(0.025)	(0.025)
Broad Money to GDP		−0.00003	0.001
		(0.001)	(0.001)
Financial Inclusion		−0.001***	−0.001***
		(0.0002)	(0.0002)
Crypto ATM Count		0.011***	0.011***
		(0.004)	(0.004)
Crypto Exchange: Count		−0.023***	−0.015***
		(0.003)	(0.003)
Crypto Exchange: Volume		0.014***	0.014***
		(0.001)	(0.001)
Trade Subordinance			0.177***
			(0.029)
FDI Subordinance			0.224***
			(0.025)
Year	0.028***	0.020***	0.014***
	(0.001)	(0.002)	(0.002)
Constant	−0.090	−0.036	−0.177***
	(0.060)	(0.061)	(0.062)
Observations	9,576	9,504	9,504
R^2	0.143	0.163	0.175
Adjusted R^2	0.142	0.162	0.174
Residual Std. Error	0.441 (df = 9566)	0.438 (df = 9489)	0.435 (df = 9487)
F Statistic	176.660*** (df = 9; 9566)	131.988*** (df = 14; 9489)	126.016*** (df = 16; 9487)
Note:			*p<0.1; **p<0.05; ***p<0.01

loses significance. Similarly, as I show in table 4.7, these covariates remain significant predictors of binary radical status among CBDC projects, defined as an average score greater than 1,[2] showing significantly more accentuated effects on subordinance coefficients.

Similarly, these results are consistent when speciifed on any one design choice among projects. As I show in table 4.3, along each of the three design features, domestic and international push factors remain consistent and significant predictors of more radical choices even when disaggregated from project average scores. Notably, the effect of each predictor remains quite stable across all three features, suggesting that the average effects reported in table 4.2 are not idiosyncrasies of distributional skews along any one of the aggregated design features. As I show in the appendix, these results too are consistent with HC1 standard errors shown in table 4.8. When estimated with country and year fixed effects, the estimate for FDI loses consistency and significance, however trade remains positive in all models and significant in all cases but architecture, as I show in table 4.9.[3]

ii. Why do countries have (dis)similar CBDC designs?

Independently of specific design choices, as more countries announce technical features of their respective CBDC projects, there is an emergent and growing network of similarity in these design choices. This system of pairwise (dis)similarity among CBDC projects constitutes a critical outcome of interest in understanding the role of mutual economic and political exposure in shaping countries' respective choices. As discussed earlier, we should expect pairwise similarity in CBDC design choices among countries with denser political and economic ties. Namely, along economic lines of trade and foreign direct investment, and political lines of alliances and IGO co-membership, we should expect higher rates of shared design features among CBDC projects in the world. Conversely, we should expect dissimilar designs among countries who have historical sanctions relationships. As I show below in table 4.4, these expectations see support in the empirical data.

First, mutual domestic conditions offer some interesting baselines for shared CBDC designs. Notably, larger and more developed economies - both along economic mass and financial development - share fewer design features than smaller and less developed economies, suggesting a greater degree of variation among larger states' CBDC projects and design choices. Mutual push factors see mixed support in the model, with higher counts of mutual cryptocurrency ATMs and mutual volume on cryptocurrency exchanges associated with greater similarity in designs. Contrary to expectations, counts of mutual cryptocurrency exchanges is associated with lower design similarity, potentially as more exchanges independent of volume implies lower per-exchange risk in an observation. Control variables largely reflect expected relationships, with higher counts of observed design choices associated with

[2]As the project average is composed of the radical score sum across all design features normalized by the number of design features announced for a country, this threshold identifies projects where atleast one design choice takes a radical score of 2.

[3]These models omit estimates for WIPO competitiveness, central bank independence, and Orbis network centrality which vary at the country-level and are therefore collinear with country fixed effects.

Table 4.3: OLS for Radical Score by CBDC Project Across Design Features

	Dependent Variable: CBDC Project Radical Score (By Feature)		
	Radical: Architecture	Radical: Infrastructure	Radical: Access
	(1)	(2)	(3)
GDP per capita	0.143***	0.096***	0.151***
	(0.018)	(0.021)	(0.020)
Inflation	0.002***	0.003***	0.004***
	(0.0002)	(0.0002)	(0.0002)
Cellphone per capita	−0.001***	−0.001***	−0.0004***
	(0.0001)	(0.0001)	(0.0001)
Gov. Effectiveness	0.077***	0.025***	0.054***
	(0.007)	(0.008)	(0.008)
WIPO Index	−0.001***	−0.00004	0.002***
	(0.0002)	(0.0002)	(0.0002)
Fin. Dev. Index	−0.078**	−0.189***	0.010
	(0.031)	(0.036)	(0.034)
Central Bank Independence	−0.172***	−0.176***	−0.268***
	(0.019)	(0.022)	(0.021)
Orbis Network Centrality	−0.063***	0.091***	0.021
	(0.015)	(0.017)	(0.016)
Broad Money to GDP	−0.001*	0.001*	0.0002
	(0.001)	(0.001)	(0.001)
Financial Inclusion	−0.002***	0.0002	−0.0002
	(0.0001)	(0.0002)	(0.0002)
Crypto ATM Count	−0.001	0.015***	0.010***
	(0.002)	(0.003)	(0.002)
Crypto Exchange: Count	−0.008***	−0.015***	0.001
	(0.002)	(0.002)	(0.002)
Crypto Exchange: Volume	0.005***	0.014***	0.007***
	(0.001)	(0.001)	(0.001)
Trade Subordinance	0.095***	0.123***	0.102***
	(0.017)	(0.020)	(0.019)
FDI Subordinance	0.140***	0.084***	0.035**
	(0.015)	(0.018)	(0.017)
Year	0.014***	0.001	0.004***
	(0.001)	(0.001)	(0.001)
Constant	−0.023	−0.119***	−0.297***
	(0.037)	(0.044)	(0.040)
Design Feature	Architecture	Infrastructure	Access
Observations	9,504	9,504	9,504
R^2	0.178	0.160	0.152
Adjusted R^2	0.176	0.159	0.151
Residual Std. Error (df = 9487)	0.263	0.308	0.285
F Statistic (df = 16; 9487)	128.264***	113.126***	106.508***

Note: *p<0.1; **p<0.05; ***p<0.01

higher pairwise scores and an increase in the rate of similar CBDC projects over time. Interestingly, higher level of minimum CBDC project development in a dyad is negatively related to similarity in CBDC design choices, suggesting that more developed projects have fewer similar counterparts than projects early in development, all else equal.

Second, these results provide some support for expectations around exposure pressures facing CBDC designs. Notably, both measures of economic exposure in trade and FDI are positive and significant predictors of shared CBDC designs. As each of these measures the share of dyadic flows out of total flows involving either state in a dyad, every 10% higher concentration of trade among top 5 partners is associated with 1.2% higher similarity in CBDC design, and every 10% higher concentration in FDI among top 5 partners is associated with approximately 3.6% higher CBDC design similarity. Interestingly, political exposure operates against expectations, with dyadic alliance associated with 3.3% lower similarity, and total IGO co-membership associated with 19% lower similarity. Dyadic sanctions are associated with 4.1% higher similarity.

Third and finally, these data also allow for specific assessment of peer effects among particular countries. One crucial country in contemporary discourse about the global politics of CBDC development is China, whose project has largely been seen as an accelerator of progress among other countries, for better or worse. As explored in the preceding chapter on CBDC project timing, these data show that Chinese signals of progress indeed have an accelerating effect on other countries' projects. In the case of design, we can similarly assess the unique drivers of pairwise design similarity with Chinese counterparts. One simple approach to this issue involves augmenting the model presented in table 4.4 with an interaction term with each pull factor for dyadic observations that include China.

Notably, the dyanmics of pairwise design similarity are distinct for China as compared to average global effects. In contrast with the globally positive average effects of trade and FDI relationships on CBDC design similarity, Chinese effects are opposite in this domain, with each positive predictor showing significant negative effects in pairs including China. Similarly, whereas alliances are, on average, negative predictors of design similarity globally, they are positive predictors of CBDC design similarity in observations including China's project. Sanctions remain a positive predictor and IGO co-membership a negative predictor in observations including China, akin to global effects. These result suggest that, while Chinese influence in design similarity may not propagate through economic ties - potentially due to disruption of global economic networks under the US-China trade war - more political vectors of design contagion are significant predictors of spillover effects in CBDC design in dyads involving the Chinese project. Results from both models are presented in table 4.10 in the order presented here.

These main results are consistent under a variety of alternate model specifications. As I show in table 4.11, effects are similar when this model is estimated with HC1 standard errors, and table 4.12 shows that these results are consistent with country and year fixed effects. Notably, as I show in table 4.13, the primary exposure effect for trade becomes negative and insignificant when estimated as the total share of all trade, not only among top 5 trading partners, whereas FDI remains positive and significant with a more pronounced estimate

Table 4.4: OLS for Normalized Shared CBDC Design Score

	Dependent Variable: Pairwise CBDC Design Score (Normalized)		
	(1)	(2)	(3)
GDP (Mean)	0.059	0.189	−0.404
	(0.225)	(0.281)	(0.280)
Population (Mean)	−0.003	−0.051	0.079
	(0.109)	(0.126)	(0.125)
Inflation (Mean)	0.014	−0.0004	−0.031*
	(0.014)	(0.018)	(0.018)
Cellphone per capita (Mean)	−0.011	0.011	0.007
	(0.011)	(0.012)	(0.011)
Gov. Effectiveness (Mean)	0.233	2.112**	5.397***
	(0.698)	(0.929)	(1.017)
WIPO Index (Mean)	0.036*	0.035	0.128***
	(0.021)	(0.024)	(0.027)
Fin. Dev. Index (Mean)	−0.063**	−0.185***	−0.233***
	(0.029)	(0.042)	(0.042)
Central Bank Independence (Mean)	−2.575	−10.571***	−11.677***
	(1.932)	(2.651)	(2.611)
Orbis Network Centrality (Mean)	7.567***	21.477***	19.058***
	(1.391)	(2.498)	(2.501)
Broad Money to GDP (Mean)		0.175***	0.172***
		(0.046)	(0.046)
Financial Inclusion (Mean)		−0.047**	−0.064***
		(0.019)	(0.019)
Crypto ATM Count (Mean)		0.649*	2.693***
		(0.379)	(0.402)
Crypto Exchange: Count (Mean)		−0.972***	−0.826***
		(0.124)	(0.123)
Crypto Exchange: Volume (Mean)		0.192***	0.196***
		(0.050)	(0.050)
Trade Share (Top 5)			0.122***
			(0.030)
FDI Share (Top 5)			0.359***
			(0.030)
Ally (Binary)			−3.226***
			(0.738)
IGO Co-Membership			−0.193***
			(0.021)
Sanctions (Binary)			4.145***
			(1.008)
Minimum Dev.	0.402**	0.309	−0.023
	(0.183)	(0.223)	(0.220)
Count Observed Features	19.549***	18.645***	18.969***
	(0.287)	(0.339)	(0.335)
Year	0.544	2.573***	2.104**
	(0.816)	(0.942)	(0.925)
Constant	−7.185	−14.636	2.170
	(7.994)	(9.844)	(9.861)
Observations	8,175	6,005	6,005
R^2	0.437	0.463	0.487
Adjusted R^2	0.436	0.461	0.485
Residual Std. Error	16.421 (df = 8162)	16.045 (df = 5987)	15.692 (df = 5982)
Note:			*p<0.1; **p<0.05; ***p<0.01

under this specification. This suggests that, atleast for trade relations, only the highest volume trading partners are likely to see relative effects of trade flow on CBDC similarity outcomes. Finally, as I show in table 4.14, these results remain consistent when specified with a binary outcome measuring any shared design feature among CBDC projects and a binary predictor for top 5 trade or FDI partner. While trade remains positive and significant across all specifications with a binary outcome, FDI is negative and inconsistently significant, and all political exposure results remain consistent, as with other robustness tests.

4.4 Conclusion

Central bank digital currencies are an update to the technology and economics of government money. They also introduce novel collective action problems situated in familiar political dynamics at the global level. Similarly to previous instances of change in the functional design and role of money, such as internationalizing currencies, the pivot to CBDCs introduces new incentives for states' choices in designing digital money. CBDCs offer new mechanisms for changing the distribution of comparative advantage in economic relations among countries, incentivizing subordinated states to leverage this opportunity with more radical design features. Furthermore, as CBDCs are neither designed nor used in isolation, states' individual choices are also made in conditions of mutual exposure to other countries' decisions, pressuring similarity in decisions among densely connected states.

In a battery of statistical tests on a novel dataset of CBDC project timing and design, I find strong support for these dual expectations of international subordination and exposure in state-level and pairwise outcomes. In line with theoretical expectations, countries with greater levels of cryptocurrency use and greater volumes on cryptocurrency exchanges have significantly more radical CBDC designs, and countries with higher levels of subordinance in global networks of trade and investment also have significantly more radical design choices. Similarly, at the pairwise level, we see strong support for economic exposure facilitating simialrity in CBDC designs among countries, with both trade and FDI flows significantly associated with higher scores on a CBDC similarity index. While political exposure appears either insignificant, in the case of sanctions, or counter to expectations, in the cases of alliance and IGO exposure, this suggests that economic interdependence may play a greater role in shaping interoperability among early CBDC projects than political interdependence.

This research offers new avenues for future work on digital money, which should leverage the active volatility in the contemporary policy space to understand these dynamics in real time. Specifically, future work should continue to augment these data on CBDC design choices as more countries begin and announce their own designs. Furthermore, future work should explore alternative coding strategies for measuring CBDC design which expands upon the BIS framework in ways which include greater technical detail, an extension which will become yet more viable as more policy and academic work is conducted in this space. Finally, future research should leverage more refined models for assessing pairwise similarity in CBDC design, potentially drawing on rich scholarship in network science which provides analytical frameworks for entire networks as dependent variables (Cranmer and B. A. Desmarais 2011).

Finally, these findings also have clear policy implications. Namely, the intersection of radical design through subordination and pairwise similarity through exposure suggests a world of potential interoperability problems among fiat currencies in the not-distant future. More simply, whereas today's global economy operates largely smoothly across many currencies in the world, stark differences in technical design of newly upgraded government money might artificially interrupt and rewire patterns of economic exchange among countries. For this reason, these findings suggest a need for interstate, and particularly for transnational coordination at the central bank level, to ensure the continuation of smooth interstate exchange as countries proceed with their CBDC projects in the coming decade.

4.5 Appendix

Table 4.5: OLS for Average Radical Score by CBDC Project, HC1 S.E.

	Dependent Variable: CBDC Project Radical Score (Average)		
	(1)	(2)	(3)
GDP per capita	0.297***	0.288***	0.271***
	(0.035)	(0.036)	(0.036)
Inflation	0.005***	0.005***	0.005***
	(0.0004)	(0.0004)	(0.0004)
Cellphone per capita	−0.001***	−0.001***	−0.001***
	(0.0002)	(0.0002)	(0.0002)
Gov. Effectiveness	0.040***	0.064***	0.077***
	(0.015)	(0.015)	(0.015)
WIPO Index	−0.002***	−0.002***	−0.001***
	(0.0003)	(0.0004)	(0.0004)
Fin. Dev. Index	−0.322***	−0.314***	−0.312***
	(0.069)	(0.072)	(0.071)
Central Bank Independence	−0.410***	−0.413***	−0.364***
	(0.036)	(0.034)	(0.032)
Orbis Network Centrality	0.104***	0.062**	0.037
	(0.025)	(0.025)	(0.025)
Broad Money to GDP		−0.00003	0.001
		(0.001)	(0.001)
Financial Inclusion		−0.001***	−0.001***
		(0.0003)	(0.0003)
Crypto ATM Count		0.011***	0.011***
		(0.004)	(0.004)
Crypto Exchange: Count		−0.023***	−0.015***
		(0.005)	(0.005)
Crypto Exchange: Volume		0.014***	0.014***
		(0.002)	(0.002)
Trade Subordinance			0.177***
			(0.021)
FDI Subordinance			0.224***
			(0.025)
Year	0.028***	0.020***	0.014***
	(0.002)	(0.002)	(0.002)
Constant	−0.090*	−0.036	−0.177***
	(0.048)	(0.050)	(0.050)
Observations	9576	9504	9504
Observations	9,576	9,504	9,504
R^2	0.143	0.163	0.175
Adjusted R^2	0.142	0.162	0.174
Residual Std. Error	0.441 (df = 9566)	0.438 (df = 9489)	0.435 (df = 9487)
F Statistic	176.660*** (df = 9; 9566)	131.988*** (df = 14; 9489)	126.016*** (df = 16; 9487)
Note:			*p<0.1; **p<0.05; ***p<0.01

Table 4.6: Fixed Effects Models for Average Radical Score by CBDC Project

	Dependent Variable: CBDC Project Radical Score (Average)		
	(1)	(2)	(3)
GDP per capita	0.133***	0.501***	0.355***
	(0.033)	(0.040)	(0.046)
Inflation	0.003***	0.003***	0.003***
	(0.0004)	(0.0003)	(0.0004)
Cellphone per capita	−0.002***	0.0003*	−0.001**
	(0.0001)	(0.0002)	(0.0003)
Gov. Effectiveness	0.176***	0.045***	0.153***
	(0.032)	(0.012)	(0.032)
WIPO Index		−0.001***	
		(0.0003)	
Fin. Dev. Index	−0.584***	−0.352***	−0.571***
	(0.161)	(0.050)	(0.161)
Central Bank Independence		−0.382***	
		(0.031)	
Orbis Network Centrality		0.066***	
		(0.024)	
Broad Money to GDP	−0.001	0.002*	−0.002
	(0.002)	(0.001)	(0.002)
Financial Inclusion	−0.004***	−0.001***	−0.005***
	(0.001)	(0.0002)	(0.001)
Crypto ATM Count	0.018***	0.020***	0.028***
	(0.004)	(0.004)	(0.005)
Crypto Exchange: Count	−0.011***	−0.020***	−0.016***
	(0.003)	(0.003)	(0.003)
Crypto Exchange: Volume	0.010***	0.014***	0.009***
	(0.001)	(0.001)	(0.001)
Trade Subordinance	0.382***	0.134***	0.500***
	(0.121)	(0.028)	(0.121)
FDI Subordinance	−0.064	0.272***	0.023
	(0.043)	(0.025)	(0.046)
Year	0.021***		
	(0.003)		
Country Fixed Effects?	Yes	No	Yes
Year Fixed Effects?	No	Yes	Yes
Observations	9,504	9,504	9,504
R^2	0.324	0.211	0.345
Adjusted R^2	0.319	0.208	0.339
Residual Std. Error	0.395 (df = 9434)	0.425 (df = 9475)	0.389 (df = 9422)

Note: *p<0.1; **p<0.05; ***p<0.01

Table 4.7: Regressions for Binary Radical CBDC Project (Average Over 1)

	Dependent Variable: CBDC Project Radical (Binary)		
	(1)	(2)	(3)
GDP per capita	3.966***	3.966***	0.037**
	(0.368)	(0.328)	(0.015)
Inflation	0.038***	0.038***	0.002***
	(0.004)	(0.003)	(0.0002)
Cellphone per capita	0.018***	0.018***	−0.001***
	(0.002)	(0.002)	(0.0001)
Gov. Effectiveness	1.163***	1.163***	0.039***
	(0.208)	(0.211)	(0.014)
WIPO Index	−0.027***	−0.027***	
	(0.006)	(0.007)	
Fin. Dev. Index	−6.077***	−6.077***	−0.445***
	(0.792)	(0.784)	(0.074)
Central Bank Independence	−6.384***	−6.384***	
	(0.514)	(0.561)	
Orbis Network Centrality	1.893***	1.893***	
	(0.459)	(0.518)	
Broad Money to GDP	0.037***	0.037***	−0.001
	(0.011)	(0.011)	(0.001)
Financial Inclusion	−0.027***	−0.027***	−0.001*
	(0.004)	(0.004)	(0.0003)
Crypto ATM Count	0.332***	0.332***	0.019***
	(0.057)	(0.046)	(0.002)
Crypto Exchange: Count	−0.144***	−0.144***	−0.002
	(0.035)	(0.032)	(0.002)
Crypto Exchange: Volume	0.026***	0.026***	0.002***
	(0.010)	(0.008)	(0.001)
Trade Subordinance	2.205***	2.205***	0.404***
	(0.497)	(0.498)	(0.051)
FDI Subordinance	3.801***	3.801***	0.075***
	(0.367)	(0.321)	(0.017)
Year	1.707***	1.707***	
	(0.118)	(0.099)	
Constant	−26.202***	−26.202***	
	(1.782)	(1.462)	
Model	Logit	Logit (HC1)	Fixed Effects OLS
Observations	9,504	9,504	9,504
R^2			0.327
Adjusted R^2			0.322
Log Likelihood	−805.800	−805.800	
Akaike Inf. Crit.	1,645.600	1,645.600	
Residual Std. Error			0.180 (df = 9435)

Note: *p<0.1; **p<0.05; ***p<0.01

Table 4.8: OLS for Radical Score by CBDC Project Across Design Features, HC1 S.E.

	Dependent Variable: CBDC Project Radical Score (By Feature)		
	Radical: Architecture	Radical: Infrastructure	Radical: Access
	(1)	(2)	(3)
GDP per capita	0.143***	0.096***	0.151***
	(0.028)	(0.024)	(0.022)
Inflation	0.002***	0.003***	0.004***
	(0.0003)	(0.0004)	(0.0003)
Cellphone per capita	−0.001***	−0.001***	−0.0004***
	(0.0001)	(0.0001)	(0.0001)
Gov. Effectiveness	0.077***	0.025**	0.054***
	(0.008)	(0.011)	(0.010)
WIPO Index	−0.001***	−0.00004	0.002***
	(0.0002)	(0.0003)	(0.0001)
Fin. Dev. Index	−0.078**	−0.189***	0.010
	(0.034)	(0.050)	(0.050)
Central Bank Independence	−0.172***	−0.176***	−0.268***
	(0.019)	(0.026)	(0.024)
Orbis Network Centrality	−0.063***	0.091***	0.021
	(0.014)	(0.018)	(0.015)
Broad Money to GDP	−0.001	0.001	0.0002
	(0.001)	(0.001)	(0.001)
Financial Inclusion	−0.002***	0.0002	−0.0002**
	(0.0003)	(0.0001)	(0.0001)
Crypto ATM Count	−0.001	0.015***	0.010***
	(0.002)	(0.003)	(0.002)
Crypto Exchange: Count	−0.008***	−0.015***	0.001
	(0.002)	(0.004)	(0.003)
Crypto Exchange: Volume	0.005***	0.014***	0.007***
	(0.001)	(0.002)	(0.001)
Trade Subordinance	0.095***	0.123***	0.102***
	(0.012)	(0.016)	(0.017)
FDI Subordinance	0.140***	0.084***	0.035***
	(0.016)	(0.014)	(0.013)
Year	0.014***	0.001	0.004***
	(0.001)	(0.001)	(0.001)
Constant	−0.023	−0.119***	−0.297***
	(0.036)	(0.042)	(0.035)
Design Feature	Architecture	Infrastructure	Access
Observations	9,504	9,504	9,504
R^2	0.178	0.160	0.152
Adjusted R^2	0.176	0.159	0.151
Residual Std. Error (df = 9487)	0.263	0.308	0.285
F Statistic (df = 16; 9487)	128.264***	113.126***	106.508***

Note: *p<0.1; **p<0.05; ***p<0.01

Table 4.9: OLS for Radical Score by CBDC Project Across Design Features, Fixed Effects

	Dependent Variable: CBDC Project Radical Score (Average)		
	(1)	(2)	(3)
GDP per capita	0.170***	0.301***	0.271***
	(0.028)	(0.033)	(0.029)
Inflation	0.001***	0.002***	0.002***
	(0.0002)	(0.0003)	(0.0003)
Cellphone per capita	0.0003**	−0.001***	−0.001***
	(0.0002)	(0.0002)	(0.0002)
Gov. Effectiveness	0.075***	0.045**	−0.047**
	(0.019)	(0.023)	(0.020)
Fin. Dev. Index	−0.613***	−0.252**	0.745***
	(0.097)	(0.115)	(0.103)
Broad Money to GDP	−0.008***	−0.001	−0.002**
	(0.001)	(0.001)	(0.001)
Financial Inclusion	−0.005***	0.0003	0.002***
	(0.0005)	(0.001)	(0.0005)
Crypto ATM Count	0.010***	0.028***	0.019***
	(0.003)	(0.003)	(0.003)
Crypto Exchange: Count	−0.014***	−0.006***	0.002
	(0.002)	(0.002)	(0.002)
Crypto Exchange: Volume	0.004***	0.008***	0.006***
	(0.001)	(0.001)	(0.001)
Trade Subordinance	0.243***	0.391***	1.084***
	(0.073)	(0.086)	(0.078)
FDI Subordinance	0.055**	−0.052	−0.131***
	(0.028)	(0.033)	(0.029)
Fixed Effects	Country and Year	Country and Year	Country and Year
Design Feature	Architecture	Infrastructure	Access
Observations	9,504	9,504	9,504
R^2	0.352	0.321	0.356
Adjusted R^2	0.346	0.315	0.350
Residual Std. Error (df = 9422)	0.235	0.278	0.249
Note:			*p<0.1; **p<0.05; ***p<0.01

Table 4.10: OLS for Normalized Shared CBDC Design Score, Chinese Peer Effects

	Dependent Variable: Pairwise CBDC Design Score (Normalized)	
	(1)	(2)
GDP (Mean)	2.394**	0.226
	(1.158)	(0.283)
Population (Mean)	−0.203	−0.161
	(0.576)	(0.126)
Inflation (Mean)	0.033	−0.021
	(0.066)	(0.018)
Cellphone per capita (Mean)	0.163	0.002
	(0.330)	(0.011)
Gov. Effectiveness (Mean)	−6.773	1.389
	(5.044)	(1.117)
WIPO Index (Mean)	0.313***	0.040
	(0.104)	(0.029)
Fin. Dev. Index (Mean)	0.330	−0.273***
	(0.201)	(0.041)
Central Bank Independence (Mean)	34.785***	−12.750***
	(12.611)	(2.554)
Orbis Network Centrality (Mean)	−89.635***	12.279***
	(12.137)	(2.513)
Broad Money to GDP (Mean)	0.879***	0.282***
	(0.153)	(0.046)
Financial Inclusion (Mean)	0.732***	−0.034*
	(0.076)	(0.018)
Crypto ATM Count (Mean)	−5.160***	1.365***
	(1.629)	(0.436)
Crypto Exchange: Count (Mean)	3.904***	−0.671***
	(0.533)	(0.123)
Crypto Exchange: Volume (Mean)	−0.488	0.381***
	(0.309)	(0.050)
Dyad with China		33.351***
		(6.494)
Trade Share (Top 5)	−0.308***	0.452***
	(0.069)	(0.046)
FDI Share (Top 5)	−0.019	0.400***
	(0.066)	(0.035)
Ally (Binary)	18.716***	−4.617***
	(4.931)	(0.733)
IGO Co-Membership	−0.467***	−0.191***
	(0.096)	(0.022)
Sanctions (Binary)	3.815	2.328**
	(2.976)	(1.115)
Minimum Dev.	2.950***	0.141
	(0.639)	(0.218)
Count Observed Features	14.974***	18.851***
	(1.063)	(0.330)
Year	18.886	2.961***
	(11.720)	(0.907)
Dyad with China * Trade Share (Top 5)		−0.553***
		(0.067)
Dyad with China * FDI Share (Top 5)		−0.155**
		(0.077)
Dyad with China * Ally (Binary)		21.229***
		(5.609)
Dyad with China * IGO Co-Membership		−0.603***
		(0.099)
Dyad with China * Sanctions (Binary)		4.898*
		(2.536)
Constant	−157.272**	0.097
	(78.462)	(9.650)
Observations	Dyads with China	All Dyads
Observations	469	6,005
R^2	0.752	0.512
Adjusted R^2	0.740	0.509
Residual Std. Error	11.046 (df = 446)	15.310 (df = 5976)
Note:		*p<0.1; **p<0.05; ***p<0.01

Table 4.11: OLS for Normalized Shared CBDC Design Score, HC1 S.E.

	Dependent Variable: Pairwise CBDC Design Score (Normalized)		
	(1)	(2)	(3)
GDP (Mean)	0.059	0.189	−0.404
	(0.220)	(0.270)	(0.272)
Population (Mean)	−0.003	−0.051	0.079
	(0.106)	(0.126)	(0.128)
Inflation (Mean)	0.014	−0.0004	−0.031*
	(0.014)	(0.017)	(0.017)
Cellphone per capita (Mean)	−0.011	0.011	0.007
	(0.012)	(0.014)	(0.014)
Gov. Effectiveness (Mean)	0.233	2.112**	5.397***
	(0.694)	(0.940)	(1.036)
WIPO Index (Mean)	0.036*	0.035	0.128***
	(0.020)	(0.023)	(0.028)
Fin. Dev. Index (Mean)	−0.063**	−0.185***	−0.233***
	(0.026)	(0.042)	(0.043)
Central Bank Independence (Mean)	−2.575	−10.571***	−11.677***
	(1.906)	(2.621)	(2.523)
Orbis Network Centrality (Mean)	7.567***	21.477***	19.058***
	(1.310)	(2.485)	(2.552)
Broad Money to GDP (Mean)		0.175***	0.172***
		(0.037)	(0.038)
Financial Inclusion (Mean)		−0.047**	−0.064***
		(0.019)	(0.019)
Crypto ATM Count (Mean)		0.649	2.693***
		(0.396)	(0.420)
Crypto Exchange: Count (Mean)		−0.972***	−0.826***
		(0.112)	(0.113)
Crypto Exchange: Volume (Mean)		0.192***	0.196***
		(0.050)	(0.049)
Trade Share (Top 5)			0.122***
			(0.031)
FDI Share (Top 5)			0.359***
			(0.037)
Ally (Binary)			−3.226***
			(0.668)
IGO Co-Membership			−0.193***
			(0.019)
Sanctions (Binary)			4.145***
			(0.909)
Minimum Dev.	0.402**	0.309	−0.023
	(0.184)	(0.229)	(0.228)
Count Observed Features	19.549***	18.645***	18.969***
	(0.303)	(0.365)	(0.367)
Year	0.544	2.573**	2.104*
	(1.054)	(1.268)	(1.236)
Constant	−7.185	−14.636	2.170
	(8.762)	(10.827)	(10.827)
Observations			
Observations	8,175	6,005	6,005
R^2	0.437	0.463	0.487
Adjusted R^2	0.436	0.461	0.485
Residual Std. Error	16.421 (df = 8162)	16.045 (df = 5987)	15.692 (df = 5982)
Note:			*p<0.1; **p<0.05; ***p<0.01

Table 4.12: OLS for Normalized Shared CBDC Design Score, Fixed Effects

	Dependent Variable: Pairwise CBDC Design Score (Normalized)		
	(1)	(2)	(3)
GDP (Mean)	1.112***	0.726	0.618
	(0.400)	(0.452)	(0.449)
Population (Mean)	−0.473***	−0.676***	−0.660***
	(0.165)	(0.191)	(0.189)
Inflation (Mean)	0.068**	0.077**	0.072**
	(0.029)	(0.034)	(0.034)
Cellphone per capita (Mean)	−0.026	0.018	0.026
	(0.030)	(0.031)	(0.031)
Gov. Effectiveness (Mean)	82.073***	20.177	18.354
	(14.904)	(18.606)	(18.444)
Fin. Dev. Index (Mean)	−2.900***	1.416*	1.254
	(0.555)	(0.820)	(0.813)
Broad Money to GDP (Mean)		0.115	0.068
		(0.105)	(0.104)
Crypto ATM Count (Mean)		−17.132**	−20.305***
		(7.019)	(6.969)
Crypto Exchange: Count (Mean)		3.392***	3.137***
		(0.739)	(0.736)
Crypto Exchange: Volume (Mean)		−0.016	0.004
		(0.108)	(0.107)
Trade Share (Top 5)			0.273***
			(0.033)
FDI Share (Top 5)			0.086***
			(0.031)
Ally (Binary)			−1.454
			(0.967)
IGO Co-Membership			−0.131***
			(0.029)
Sanctions (Binary)			3.164***
			(1.039)
Minimum Dev.	−0.509*	0.252	0.444
	(0.267)	(0.314)	(0.313)
Count Observed Features	19.864***	19.510***	19.854***
	(0.462)	(0.518)	(0.516)
Fixed Effects	Country and Year	Country and Year	Country and Year
Observations	8,175	6,005	6,005
R^2	0.530	0.568	0.576
Adjusted R^2	0.526	0.563	0.571
Residual Std. Error	15.063 (df = 8096)	14.456 (df = 5932)	14.325 (df = 5927)
Note:			*p<0.1; **p<0.05; ***p<0.01

Table 4.13: OLS for Normalized Shared CBDC Design Score, All Trade and FDI

	Dependent Variable: Pairwise CBDC Design Score (Normalized)
GDP (Mean)	-0.176
	(0.287)
Population (Mean)	0.007
	(0.127)
Inflation (Mean)	-0.026
	(0.018)
Cellphone per capita (Mean)	0.008
	(0.012)
Gov. Effectiveness (Mean)	2.556^{**}
	(1.062)
WIPO Index (Mean)	0.057^{**}
	(0.027)
Fin. Dev. Index (Mean)	-0.216^{***}
	(0.042)
Central Bank Independence (Mean)	-8.846^{***}
	(2.625)
Orbis Network Centrality (Mean)	15.827^{***}
	(2.518)
Broad Money to GDP (Mean)	0.207^{***}
	(0.046)
Financial Inclusion (Mean)	-0.053^{***}
	(0.019)
Crypto ATM Count (Mean)	1.820^{***}
	(0.420)
Crypto Exchange: Count (Mean)	-0.807^{***}
	(0.124)
Crypto Exchange: Volume (Mean)	0.223^{***}
	(0.050)
Trade Share (All)	-0.151
	(0.100)
FDI Share (All)	1.230^{***}
	(0.114)
Ally (Binary)	-2.311^{***}
	(0.747)
IGO Co-Membership	-0.177^{***}
	(0.022)
Sanctions (Binary)	3.294^{***}
	(1.027)
Minimum Dev.	-0.102
	(0.223)
Count Observed Features	19.357^{***}
	(0.340)
Year	2.551^{***}
	(0.932)
Constant	1.225
	(9.972)
Observations	6,005
R^2	0.480
Adjusted R^2	0.478
Residual Std. Error	15.795 (df = 5982)
Note:	*p<0.1; **p<0.05; ***p<0.01

Table 4.14: OLS for Normalized Shared CBDC Design Score, Any Shared Feature

	Dependent Variable: Pairwise CBDC Design Score (Binary)		
	(1)	(2)	(3)
GDP (Mean)	−0.030***	−0.030***	0.021**
	(0.006)	(0.006)	(0.010)
Population (Mean)	−0.002	−0.002	−0.019***
	(0.003)	(0.003)	(0.004)
Inflation (Mean)	−0.003***	−0.003***	0.002***
	(0.0004)	(0.0004)	(0.001)
Cellphone per capita (Mean)	0.0001	0.0001	0.001
	(0.0002)	(0.0003)	(0.001)
Gov. Effectiveness (Mean)	0.142***	0.142***	−0.041
	(0.022)	(0.023)	(0.393)
WIPO Index (Mean)	0.002***	0.002***	
	(0.001)	(0.001)	
Fin. Dev. Index (Mean)	−0.003***	−0.003***	0.043**
	(0.001)	(0.001)	(0.017)
Central Bank Independence (Mean)	−0.175***	−0.175***	
	(0.056)	(0.063)	
Orbis Network Centrality (Mean)	0.505***	0.505***	
	(0.054)	(0.054)	
Broad Money to GDP (Mean)	0.005***	0.005***	0.012***
	(0.001)	(0.001)	(0.002)
Financial Inclusion (Mean)	−0.003***	−0.003***	
	(0.0004)	(0.0005)	
Crypto ATM Count (Mean)	0.037***	0.037***	0.143
	(0.009)	(0.010)	(0.149)
Crypto Exchange: Count (Mean)	−0.012***	−0.012***	0.100***
	(0.003)	(0.003)	(0.016)
Crypto Exchange: Volume (Mean)	0.001	0.001	−0.0005
	(0.001)	(0.001)	(0.002)
Trade Share (Top 5)	0.234***	0.234***	0.143***
	(0.026)	(0.024)	(0.028)
FDI Share (Top 5)	0.062**	0.062**	−0.095***
	(0.028)	(0.026)	(0.027)
Ally (Binary)	−0.206***	−0.206***	−0.162***
	(0.016)	(0.016)	(0.021)
IGO Co-Membership	−0.003***	−0.003***	−0.002***
	(0.0005)	(0.0004)	(0.001)
Sanctions (Binary)	0.191***	0.191***	0.160***
	(0.022)	(0.018)	(0.022)
Minimum Dev.	−0.011**	−0.011**	−0.011
	(0.005)	(0.005)	(0.007)
Count Observed Features	0.147***	0.147***	0.054***
	(0.007)	(0.007)	(0.011)
Year	0.049**	0.049*	
	(0.020)	(0.026)	
Constant	1.222***	1.222***	
	(0.214)	(0.250)	
Specification	Standard	HC1 SE	Country and Year FE
Observations	6,005	6,005	6,005
R^2	0.194	0.194	0.356
Adjusted R^2	0.191	0.191	0.348
Residual Std. Error	0.340 (df = 5982)	0.340 (df = 5982)	0.305 (df = 5927)

Note: *p<0.1; **p<0.05; ***p<0.01

Chapter 5

Early Birds & Tardy Mice

5.1 Introduction: The Uncertain Costs of Waiting

Do first-movers have structural advantages in central bank digital currency design diffusion? While central bank digital currencies (CBDCs) can be seen on one hand as a specialized instance of technical decision-making by economic regulators, they also constitute a more general phenomenon familiar to practitioners of international political economy: choice diffusion. Indeed, much contemporary discussion on the race for CBDCs centers on the question of first-mover advantage, with some pundits arguing that first-movers enjoy significant advantages and others claiming that correct design matters more than quick action. However, these discussions have been exclusively premised on hypothetical and normative assumptions about the race for digital money, and due to the extremely early and fast-moving nature of this issue space, have not been backed by theoretical and empirical research. Instead, these arguments too often circulate in cheap talk equilibria among political decision-makers to defend existing policy interests on unadjudicated assertions about the costs of waiting.

In fact, these arguments about first-mover advantage in CBDC design resonate with a large body of network science scholarship on preferential attachment and scale-free networks, known in social science as the 'rich get richer' phenomenon. Proponents of first-mover advantages functionally argue that the race for CBDCs is a scale-free network in which first-movers enjoy preferential attachment, or in this case, a higher likelihood of diffusing their design choices to countries whose choices are made later on. Counterarguments to this perspective center on the assumption that this privilege does not exist, and that design choices made after first-movers are not meaningfully influenced by the earlier choices. Each side argues that countries' choices in CBDC design are, and are not, interdependent.

The question of interdependence in policy choices bridges scholarship in international political economy on the question of cross-border choice diffusion, and scholarship in network science on structural correlates of scale-free networks. Importantly, the question of interdependence in states' CBDC design choices over time does *not* require differentiation of the mechanisms by which that diffusion occurs, which remains a salient issue for causal inference in policy diffusion literature. Rather, to adjudicate on the question of first-mover advantages in CBDC design, I argue that what matters is whether the network of directed design choice diffusion exhibits scale-free properties, and whether first-movers enjoy the privileges of preferential attachment which accompany this form of network structure.

In this chapter, I develop a theory of generative network principles and derive testable hypotheses on the nature of first-mover advantage in directed CBDC design diffusion networks. Using data from the preceding chapter that measures month-level diffusion in countries' CBDC design choices, I show that this network exhibits structural features which favor first-movers and disproportionately favor the diffusion of more radical CBDC design choices as result. Arising from incentives tested in earlier work, namely causal factors which incentive early-moving states to pursue more radical CBDC design, these results strongly suggest that the race for CBDCs does imbue temporal privileges to faster-acting countries.

The chapter proceeds in the following sections. In the next section I propose a theory of generative network principles and identify testable hypotheses regarding the measurable implications of first-mover advantages in CBDC design diffusion networks. I specifically integrate existing theories of cross-border choice diffusion from extant scholarship in international political economy, and interface these arguments with structural findings from network science to propose hypotheses whose null assumptions imply a lack of first-mover advantage. In the following section, I describe novel empirical data measuring month-level observations in countries' CBDC design choices and directed interstate diffusion of those decisions. I subsequently present a wide battery of empirical results using various methods from social network analysis to show that directed CBDC design diffusion indeed exhibits structural correlates of first-mover advantage which disproportionately favors the diffusion of more radical CBDC design choices. I conclude the chapter with specific lines of future research and critical policy implications arising from these results.

5.2 Existing Scholarship

Extensive research in international relations and political economy has explored the questions of policy diffusion and first-mover advantages, respectively. Much less research has examined the relationship between the two among countries in the world. In this section, I briefly discuss the collections of existing research on policy diffusion and on first-mover advantage in the case of international relations and political economy, contouring both their respective states of knowledge and analytical limits. I then proceed to discuss the limitations of applying these respective bodies of scholarship to the question of diffusion and first-mover advantage in CBDC design choices, centered primarily on the directions of inference associated with each collection of work and the analytical obstacles they pose for this chapter's analysis.

i. International Policy Diffusion

Dynamics of policy diffusion are an extremely proliferative topic of study in international relations and political economy. Indeed, almost 800 articles were published on the topic of policy diffusion in political science journals in only the five decades preceding 2008, and international relations has been among the top contributing subfields to this now-expansive line of research (Graham, Shipan, and Volden 2013). While much of the work in international relations has focused on *norm* diffusion, which stands as a qualitatively distinct process from the formal adoption of regulatory outcomes (Risse 2017). The counterpart to this literature has been IR and IPE scholarship on *policy* diffusion, which explores when, how, and why countries adopt similar or identical policies in a given issue area (Simmons and Elkins 2004).

This scholarship on international policy diffusion serves as a relevant and important foundation for research on design diffusion in CBDCs, due especially to its theoretical attention to questions of interstate interdependence. Ranging from the diffusion of democratization (Gleditsch and M. D. Ward 2006) and liberalism (Simmons, Dobbin, and Garrett 2006) to capital taxation (Cao 2010), green taxation (H. Ward and Cao 2012), and financial market regulation (Way 2005), to name a small sample of this work, this extremely diverse literature has helped to explore both the substantively unique and theoretically unifying features of policy diffusion across states and over time. This scholarship is remarkable in the breadth of substantive policies which fall under its purview, and stands as an extremely useful body of work on which to expand theoretical frameworks to incorporate new issue areas.

A key element of theoretical dispute and progress in this field centers on the difficulty - or impossibility - of effectively identifying causal processes of interstate policy diffusion. On the one hand, this is due to the myriad complimentary theoretical frameworks which stand alongside diffusion, such as transfer (Marsh and Sharman 2009) and convergence (Heichel, Pape, and Sommerer 2005)). On the other hand, this difficulty arises from the wide variety of theoretical mechanisms by which diffusion might causally occur, which have historically centered on the analytical difficulties of empirically differentiating policy diffusion by competition, coercion, emulation, and learning (Braun and Gilardi 2006). These different mechanisms of diffusion respectively operate on assumptions of resource competition, interstate pressure or force, logics of homophily or appropriability, and evidence of policy success or benefits (Simmons, Dobbin, and Garrett 2006; Gilardi 2012; Shipan and Volden 2008). Indeed, the variety of these complimentary processes and internal causal mechanisms is complicated by their realistic concurrence and interdependence in global politics.

However, this difficulty of identifying causal mechanisms implicates only some studies of policy diffusion. While research which seeks to explain *why* diffusion occurs through *which* channels is subject to this theoretical difficulty, the near-impossibility of identifying causal pathways does not inhibit work that seeks to measure the system-level correlates and consequences of structural patterns in interstate policy diffusion. This is due to the fact that causal pathways are necessary components of theories which seek to explain diffusion as a dependent variable. In research which explores the consequences of diffusion patterns for structural outcomes in global relations, an underlying theory of causal mechanisms by which diffusion occurs is not necessary for measuring diffusion as an explanatory variable.

As such, while this line of scholarship has been critical for exploring a wide range of policies which have proliferated under the auspices of political and economic globalization, it remains extremely limited in one respect. Namely, virtually all studies of policy diffusion treat diffusion as the dependent variable. This omits a second but equally critical line of scholarship which explores the importance of diffusion for explaining other outcomes important to political science. While this reversed line of scholarship on diffusion processes has offered extensions of diffusion as a contextual variable in electoral contexts (Gilardi 2015), and helps explain convergence patterns in the language of interstate agreements (Morin, Pauwelyn, and Hollway 2017), there remains virtually no work which explores the effect of interstate policy diffusion as a structural cause of state-level outcomes.

ii. Structural Power as an Alternative Framework

Virtually no scholarship in international relations studies first-mover advantage within the context of policy diffusion. Indeed, important work has examined how temporal sequencing matters for consequential policy adoption across state lines, as with the case of the gold standard (Meissner 2005), and on the spillover effects of CBDC project timing in chapter 3. However, and as alluded above, scholarship on policy diffusion almost exclusively measures diffusion as an outcome, rather than as an independent or mediating variable dictating outcomes like first-mover advantage. More simply, while we have extensive theoretical and substantive knowledge on the causal mechanisms which produce diffusion, we know much less about how diffusion produces other outcomes like first-mover advantage.

A separate line of scholarship in international political economy helps to bridge this disconnect in diffusion literature, specifically the growing body of work on structural power in the global economy. This scholarship departs significantly from open-economy assumptions to explore the ways in which relational configurations among states - social structures - create and reify power relations among states as a result of their mutual positions in those structures. While arguments in this line of work date back to early discussions on system-level critiques of state-level autonomy (Block 1981), the field has seen revitalized discussion in the domain of money and finance during the post-crisis period (Culpepper 2015).

Indeed, extensive work has focused on the structural power of banks as the mechanism behind too-big-to-fail arguments in the 2008 crisis (K. Young 2015), and this work has expanded significantly to identify social pathways through which this structural power operates at the individual level (K. L. Young, Marple, and Heilman 2017). From discussions of bailout recipient selection (Culpepper and Reinke 2014), to capital regulation (Bell and Hindmoor 2017), the field has pivoted significantly to now take seriously the questions of power and agency beyond the levels of unit-level autonomy and to explore the important role of structure in outcomes within and across borders (Marsh, Akram, and Birkett 2015).

Important research in this body of scholarship has focused on the level of the state, and explored how structural power operates among sovereign units. Still originating in analysis of the global financial crisis, this work has examined the ways in which significant exogenous shocks produce disruption in otherwise reliable contextual circumstances, such as in the decay of Anglo-financial power at the structural level in years following the crisis (Winecoff 2015; Fichtner 2017). This work has helped fill gaps in open-economy literature on global monetary and financial relations by clarifying the significant role of structure in producing salient interstate outcomes like liquidity agreements (McDowell 2019) and has served as foundational building blocks for conceptions of interstate power as a function of interdependence under complex systems of relations (Farrell and Newman 2019).

This work more closely approximates the context and process inherent to the question of first-mover advantage in policy diffusion. Whereas many instances of policy diffusion matter for understanding why diffusion occurred, systems-level approaches allow us to understand diffusion as the structure of interest among states. More simply, through a perspective of structural power, we can understand diffusion processes as the *independent* variable affecting first-mover advantage as an outcome inherent to the system. Similarly, drawing on this now-expansive line of research, we can re-interpret first-mover advantage in CBDC design diffusion not as some political or economy benefit accrued to states which acted sooner than others, but as a privileged position within the complex system of policy diffusion.

Importantly, this reconception of first-mover advantage within systems of policy diffusion requires no theoretical boundaries regarding the mechanism by which the diffusion occurs. Indeed, this approach benefits from existing findings that diffusion follows predictable paths of salient economic relationships that trigger policy spillover among states in CBDC timing (chapter 3) and design (chapter 4). As such, this approach requires substantial theorization of first-mover advantage as a privileged position within the generative structure of policy diffusion in the unique case of CBDC designs and their diffusion patterns.

5.3 Theorizing First-Mover Advantage in Diffusion

First-mover advantage in CBDC design diffusion is a type of structural agenda-setting power which exists at the system level. Specifically, and in line with current debates on CBDC timing and design, first-mover advantage can be understood as a structural configuration of early-moving countries which disproportionately allows for early decisions to propagate more broadly than choices made by later-moving countries. The logic of first-mover advantage as structural agenda-setting power over later-moving states is in line with contemporary concerns regarding the speed of CBDC development, and better approximates the policy and academic discourse regarding the uncertain costs of waiting or accelerating these projects.

In order to assess whether first-movers enjoy this form of structural power, it is necessary to determine key scope conditions and observable implications. In the following sections, I first detail foundational assumptions and counterfactuals necessary to allow for first-mover advantage. I then propose a structural theory of first-mover advantage in choice diffusion, specifically identifying the system-level processes which would produce first-mover advantage in CBDC design diffusion. I conclude the section with a set of testable empirical hypotheses regarding evidence of first-mover advantage in CBDC design diffusion among countries.

For conceptual clarity, I rely on terminology established in earlier work on this topic which theoretically organizes countries in CBDC development. First-mover is used throughout this chapter to describe countries whose projects began before 5% or more of their trade partners initiated a CBDC project themselves; this does *not* refer explicitly to countries which announced design features earlier than others, though that remains a theoretical expectation of this group as explored below. Responder is used throughout the chapter to refer to all countries which initiated a CBDC project *after* 5% or more of their trading partners initiated a CBDC project. Given the results in preceding chapters, these categories have been salient outcomes and explanatory factors in CBDC projects.

i. The Possibility of First-Mover Advantage in Policy Diffusion

Arguments about first-mover advantage in CBDC design diffusion rest on several untested assumptions, each of which must be satisfied for such an advantage to be theoretically reasonable and empirically measurable. First, these arguments assume that countries who begin their projects earlier (first-movers) are also more likely to announce design features earlier than others (responders). While this may appear intuitive, an alternate framework is equally plausible, wherein responders strategically announce design features early to head off further challenge to their preferences. Indeed, a number of countries which do not satisfy the conception of first-movers in earlier research are early announcers of design features in the dataset described below. If countries whose projects began earlier than others do not also announce design features earlier than the global average, then the counterfactual remains that later-moving countries enjoy a potential advantage of waiting rather than acting quickly.

Second, these arguments assume that diffusion is occurring in the rollout of countries' CBDC design choices. As countries outnumber possible design features, there will inevitably be choice overlap, but this is not automatically a diffusion process. Countries may adopt design features in an extremely dense window of time, implying a limited degree of direction in over-time policy similarity which would constitute temporal diffusion. Countries might also exhibit low variation in the design choices they make altogether, implying an extremely dense and unambiguated collection of diffusion ties which do not inordinately privilege any country. Finally, diffusion may operate through other channels, such as along bilateral treaties or multilateral institutions, and may not intersect with project timing at all.

Third and finally, these arguments assume that under asymmetrical diffusion, countries which began work earlier are more likely to enjoy structural privileges of these directed diffusion relationships. More simply, this perspective suggests that later-moving countries are disproportionately likely to adopt the choices made by first-movers, rather than those of other late-starters who announced design choices early. This assumes that interoperability and design similarity stands as countries' highest priority in designing their digital money. Again, this assumption faces several equally viable alternatives. Countries may prioritize domestic needs over interstate interoperability, or when countries do favor interstate factors over domestic needs, they may select on other dimensions like homophily or regional proximity, which would imply clustering independent of first-mover choices.

Limited existing scholarship on the global politics of CBDCs strongly suggests that these assumptions are valid. First, early research shows that push factors like currency inefficiency and subordinance in global exchange both correlate strongly with project timing and design choices. Similarly, this work has shown that countries are extremely sensitive to other countries' choices as a result of pull forces, like economic interdependence. Not only do early projects trigger acceleration of later-moving projects, but interdependence also pulls pairwise similarity in design choices (ibid). This work strongly supports the second and third assumptions above, suggesting that first-mover advantage in CBDC design diffusion is eminently possible from a structural perspective.

These results indeed suggest that, in the context of CBDC design, countries which begin projects earlier also have an incentive to agenda-set and announce design features earlier than others. As mentioned later in the chapter, this assumption sees strong support in the empirical data used in earlier research and in this chapter, with countries who initiated projects earlier than their economic neighbors typically announcing designs 15 months before later-moving countries. Similarly, this work suggests that countries whose projects began later are pulled to mirror design choices from earlier-moving countries as a result of exposure. These existing results showing economic relationships pressuring pairwise similarity in CBDC design strongly suggest that there is indeed asymmetrical diffusion occuring, and that earlier decisions theoretically carry more weight. However, as these early results are cross-sectional, it remains unclear whether pairwise similarity operates over time, which is a key contribution and feature of the theory and tests presented in this chapter.

ii. Structural Theory of Diffusion and First-Mover Advantage

First-mover advantage at a structural level can be understood as a privileged position which disproportionately facilitates the propagation of first-movers' designs in the diffusion network, as compared to responders. As the necessary assumptions which would make this process viable have been identified above, this allows for theorization of *how* this position is achieved and what evidence would be necessary to adjudicate it. Importantly, this framework of first-mover advantage implicates structural phenomena - features of the full system of diffusion - as the primary level of analysis. As such, sociological and networks theories remain useful for hypothesizing these relationships. This theory and the following analyses rely on the logic of social networks, which measures *edges* between *nodes*, or in this case, pairwise similarity in design features (edges) between countries (nodes) in the world.

The argument that first-movers enjoy structural advantages in CBDC design diffusion centers on assumptions about edges in this network. Specifically, the argument implies a particular type of originating edge in the network, in which one or more later-moving countries (responders) adopts a design which an earlier-moving country (first-mover) announced earlier. Based on chapters 3 and 4, these ties should theoretically propagate along important economic relationships such as trade and FDI between countries. At the lowest extreme, we would expect a single connection between countries falling along their most important economic relationship. At the highest extreme, we would expect to see perfect hub-and-spoke structures surrounding first-movers by economically-intertwined responders.

A primary theoretical expectation regarding first-mover advantage in CBDC design diffusion is thus that first-movers exhibit disproportionately higher popularity in the diffusion network than responders. Notably, this should be differentiated by the direction of diffusion ties, with first-movers *sending* disproportionately more diffusion ties than responders. While we may expect responders to *receive* more ties than first-movers in this network, the results of earlier research do not necessarily imply that first-movers are privileged in both direction of ties. Furthermore, for structural first-mover advantages to exist in diffusion processes as defined above, it matters only that first-movers originate more diffusion than responders.

Differentiated likelihood of propagating designs to other countries, though, is alone insufficient for first-movers to enjoy agenda-setting power. This argument supposes not only that first-movers enjoy disproportionately greater audiences of diffusion peers, but also that this process systematically delimits the agenda-setting power of later-moving countries. While this second outcome is in part a byproduct of the pull forces which are assumed to initiate the generative edges identified above, it is also affected by the structure of the network which arises from those generative edges. Namely, there is another system-level feature which should be empirically discernible in the global network of design diffusion which foster the second outcome in this argument: differentiated functional roles.

A first approach to functional roles focuses on the role of triadic structures in the network. The logic above implies a strong tendency for edges to point from first-movers to responders as a function of their economic exposure pressuring choice similarity. As such, if first-mover advantage exists in CBDC design diffusion, we should rarely see the opposite form of edge, directed from a slow-moving country to a first-mover. A simple extension of this expectation implies that first-movers very rarely sit at the end of *two-paths*, which are pairs of edges that connect three nodes. Two-paths are important structures in networks as they help to elucidate brokerage positions held by the middle nodes in a two-path. As explored in a wide variety of sociological and network science scholarship, these brokerage positions matter enormously for social outcomes among nodes in a network with distinct intergroup relations (Gould and Fernandez 1989; Chaudhary and Warner 2015).

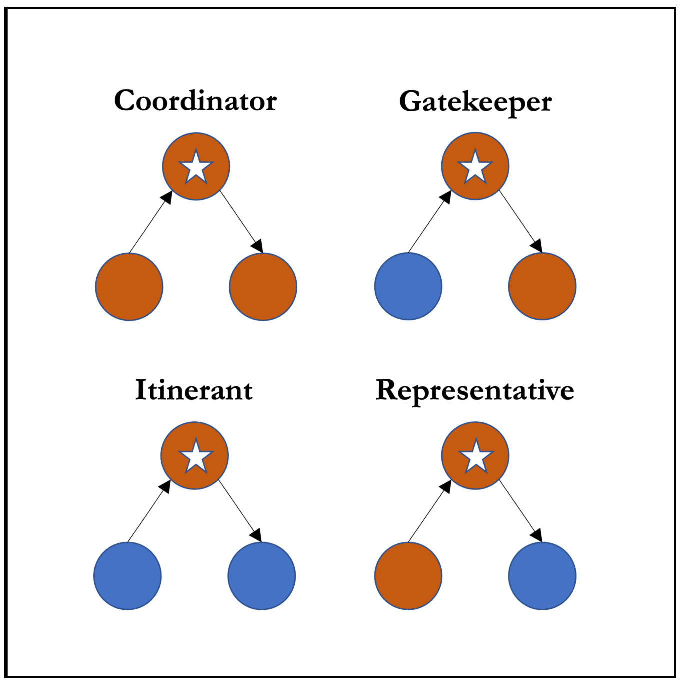
In assessing structural first-mover advantages, these two-paths serve as a consequential meso-level structure which could inordinately shape and inhibit responder countries' influence in diffusion. We can consider four principle kinds of functional roles in this network which either first-movers or responders may belong to.[1] These include **coordinator**, **itinerant**, **representative**, and **gatekeeping** roles. These are depicted in figure 5.1, specifically with attention to the role of the middle node, and briefly summarized here for interpretation.

Coordinator roles refer to brokerage among like types - such as a first-mover propagating designs from a first-mover to another first-mover. Itinerant roles invole brokerage between

[1] While other kinds of brokerage roles exist, like liason roles, these involve networks with nodes that have three or more potential group affiliations and are thus inapplicable to the binary node categorization inherent to the proposed theory in this chapter.

two nodes of one type by a node of another type, such as a responder adopting policy from a first-mover, which is later adopted by a different first-mover. Gatekeeper roles broker directed ties from one node to a node of a different type, and subsequently to a node of the same type, such as a responder adopting choices from a first-mover, and propagating that choice to another responder. Representative roles are opposite of gatekeepers, where a node receives a tie from a node of the same type, and passes to a node of the other type, such as a first-mover adopting policy from another first-mover which is then adopted by a responder.

Figure 5.1: Brokerage Roles in Directed Networks with Two Node Types



These roles matter because they imbue structural privileges to nodes contingent on the role they fill. We can consider these in a diffusion framework from a perspective of recycling, where policy diffuses strictly within a group, and a process of propagation, where a choice moves from one group to another. Structural advantages in the context of first-movers and CBDC design assume a privilege of propagating designs from within the group of first-movers to the group of responder states; this implies that first-movers theoretically play the role of representatives significantly more often than responders. In contrast, this also assumes that responders are much more likely than first-movers to serve as gatekeepers. Finally, as responders are expected to exhibit homophily in tie formation and first-movers to exhibit heterophily, we should also expect a higher rate of coordinator brokerage among responders and a higher rate of itinerant brokerage among first-movers.

A second approach to functional roles which matters equally as much to structural first-mover advantage involves hierarchical positioning in the network. As compared to the first approach with two-steps and brokerage, hierarchical positioning compares nodes as a function of the dissimilarity between their full pattern of ties to other nodes in the network. More simply, we can consider this approach as a form of community detection which groups nodes based on how similarly they behave in a shared system Borgatti 1994. In applications to global economic relations this approach has been critical for understanding *inequality* in functional roles and organizing countries along their respective functional power in systems of interstate relations (Lloyd et al. 2000; Mahutga 2006; Mahutga and D. A. Smith 2011).

In the context of CBDC design diffusion as a complex system, we should expect hierarchical clustering to organize states as a function of their role in propagating designs to other states. Specifically, when simply bifurcating the hierarchically clustered states in the diffusion network, we should expect one group to disproportionately *send* diffusion ties as compared to the other group, which should in theory include some combination of sending and receiving diffusion ties to other states. Evidence of first-mover advantage is thus two-fold; not only should we expect to observe the anticipated bifurcation of senders and others in hierarchical communities, but we should expect the sender group to be disproportionately populated by first-movers if they truly enjoy a structural advantage.

Collectively, these levels of analysis allow for triangulation of evidence to test whether first-mover advantage exists in the global network of CBDC design choice diffusion. Conditional on the foundational assumptions described in the previous section being met, we can expect clear and measurable differences between first-movers and responders at the levels of the node, the two-path, and the full network. In the next section I conclude the theoretical framework with testable hypotheses that formalize these expectations across each level.

iii. Projected Testable Hypotheses

The implications of existing evidence on CBDC timing and design offer some clear expectations for the network of design diffusion and first-mover advantage. Namely, in line with the structure of the preceding argument, these expectations exist at three distinct levels of analysis: (i) nodes and neighborhoods, (ii) two-paths and brokerage, and (iii) hierarchical communities. Importantly, while I will offer evidence to validate the foundational assumptions against their theoretical counterfactuals in the following empirical results, these do not serve as testable hypotheses and rather stand as consequential features which require description to contextualize the hypothesized relationships below.

First, this suggests observable differences at the level of nodes in the network. In line with the above, we should expect first-mover countries to have significantly lower in-degree distributions than responders, but not necessarily to have significantly higher out-degree distributions. Furthermore, we should expect first-movers to serve disproportionately as hubs in the network, but should not necessarily expect responders to serve disproportionately as spokes in those structures. Finally, we should expect significantly higher heterophily - ties established with out-group members - among first-movers as compared to responders.

Hypothesis 1A (H_{1A}): First-movers have significantly higher in-degree than responders.

Hypothesis 1B (H_{1B}): First-movers have significantly higher hub scores than responders.

Hypothesis 1C (H_{1C}): First-movers exhibit higher tie heterophily than responders.

Second, the logic outlined above suggests that first-movers should serve disproportionately as coordinators and gatekeepers in the network, while responders should more often serve as itinerants and representatives in the network. This expectation is derived from the node- and edge-level expectations regarding the timing and asymmetric proclivity for in- and out-group tie distributions, and specifically from the extended expectation that first-movers should rarely see in-ties from responders.

Hypothesis 2A (H_{2A}): First-movers significantly more often serve as representatives and itinerants in triadic network structures, compared to responders.

Hypothesis 2B (H_{2B}): Responders significantly more often serve as coordinators and gatekeepers in triadic network structures, compared to first-movers.

Third and finally, this reasoning implies two-fold expectations regarding the hierarchical clustering of the CBDC design diffusion network. Specifically, we should not only expect the network to exhibit a bifurcated community structure that differentiates primarily-sending countries from countries which have a more mixed neighborhood of sent and received diffusion ties. We should also expect that this first group of primarily-sending countries is disproportionately populated by first-movers, which is a critical test of the assumption that they enjoy agenda-setting power as defined in this structural approach.

Hypothesis 3A (H_{3A}): The design diffusion network exhibits a hierarchical community structure differentiating primary sending countries from all others.

Hypothesis 3B (H_{3B}): First-movers disproportionately compose the primarily-sending community of countries in the diffusion network, as compared to responders.

5.4 Data: Measuring CBDC Design Diffusion

In order to test these theoretical expectations, I apply a variety of tools from social network analysis on new datasets of CBDC project timing and design among countries in the world. These data are introduced in analyses from chapters 3 and 4 on the timing and design of CBDC projects across all countries in the world, built from primary evidence measuring every public announcement made by every government and cross-referenced against limited existing repositories for validity. The data measure changes in countries' public signals on their CBDC project development status and design preferences on a monthly basis, allowing for highly granular inspection of the system of CBDC projects as it evolves over time. The data include a total of 36,288 country-month observations between 2008 and the most recent observations in 2021.[2]

[2]For in-depth explanation of the full dataset, associated covariates, and its constituent coding procedures, please see the appendix for chapter 3.

Both diffusion and first-mover advantage are conceived in this theoretical framework as a network phenomenon, implying a relationship between the directed constellation of diffusion ties among countries and the relative positions countries inhabit in that network. As such, this chapter leverages the data on CBDC timing and design distinctly from the original chapters. Specifically, this chapter measures the network of CBDC design diffusion as a series of directed ties between any pair of countries which shares atleast one feature along three key dimensions of CBDC designs: architecture, infrastructure, and access. In simple terms, architecture determines which parties are liable to claims made on a CBDC, infrastructure determines which parties manage transaction ledgers, and access determines the logic of ownership over a unit of CBDC. Each of these three design features exhibits three classes of possible design options ranging from very similar to existing money (status quo), somewhat different (hybrid) and extremely different (radical).[3]

Edges in this network are defined as a directed tie between two countries which share one or more CBDC design features. Edges originate with country A and point to country B when B adopts one or more design features which were previously announced by A. All country pairs which share one or more CBDC design features share a tie in this network, and all ties are directed as a function of the order in which countries announced their choices.[4] Given the known difficulty of isolating causal reasoning of cross-border policy diffusion, a conservative approach to design propagation involves the establishment of a directed tie between each pair of actors with shared CBDC design, directed from the actor whose choice predates the other.[5] This network specification allows for a total possible number of 46,440 directed network ties established over any of 168 months in which the data were measured.

The data are transformed from existing state-level measurements to a network structure in two steps. First, country-month observations on design feature announcements are converted to a pairwise edgelist, which is a data structure that measures dyadic phenomena - in this case, pairwise similarity in design. For each of the three design features, I estimate the directed tie between every pair of countries that share a choice on that feature, originating with the country that announced the feature first and directed to the country which announced it after. These edgelists are then merged to identify the presence or absence of any pairwise design similarity between every pair of countries across every month in the dataset. The final network object is constructed from the resulting set of edges in the final set of month-level observations in the edgelist, which account for all ordered diffusion ties across

[3]For more in-depth exploration of these features please see the extensive review by the BIS (R. Auer and Böhme 2020) and expansion in chapter 4.

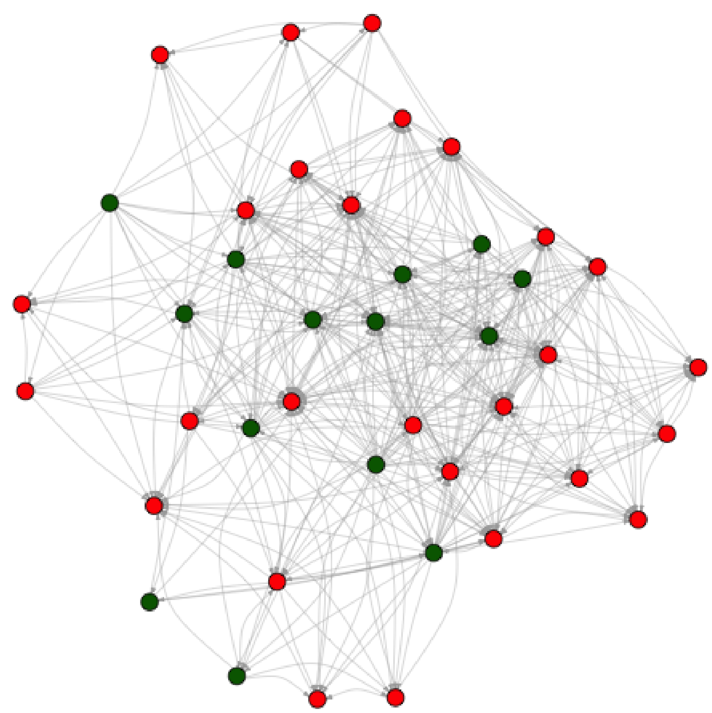
[4]While the measurement strategy allows for tie dissolution as design features are measured multiple times across countries, this outcome is not observed in the measured data.

[5]An alternate modeling strategy involves only establishing a directed tie between the most recent adopters of a shared CBDC design, rather than a tie from all preceding adopters to the most recent. This strategy assumes, however, that the nature of propagation is strictly informed by temporal sequence and artificially limits the number of measured diffusion pathways without an appropriate theoretical foundation for privileging choice diffusion in immediate steps. Furthermore, this modeling strategy implies a tree structure, which artificially introduces highly unique network features - particularly a tree structure - and would serve as an arbitrarily easier test of first-mover advantage.

every month of recorded data in the original datasets.

In order to test the main assumptions of the theory regarding first-mover advantage, all nodes in the network are coded as either first-movers or responders in line with quantitative analysis of this data in chapter 3. In line with these earlier analyses and as discussed previously, first-movers are defined as countries which initiated CBDC projects before 5% or more of their trade partners initiated a project of their own; all other countries which initiated a CBDC project after this condition expired are coded as responders and countries without a CBDC project are excluded from the network as they do not factor into theoretical assumptions about observed first-mover advantage. The final network object is presented below in figure 5.2, with first-mover nodes coded as green and responders as red.

Figure 5.2: Final Network of CBDC Design Diffusion by Actor Type



5.5 Empirical Results

This section reports empirical tests of the theoretical expectations on the generative principles of CBDC design diffusion. Following the structure of the preceding theory section, these results are organized in a bottom-up exploration of first-mover advantages in CBDC design, proceeding across three levels of analysis. I first explore relevant measures at the level of nodes (countries) and their respective neighborhoods in the network of directed design diffusion, with particular attention to popularity scores, hub and spoke structures, and patterns of homophily in ego-networks. I then turn to the distribution of functional roles across first-movers and responders and corresponding structures of community clustering associated with those functional roles in the network. Finally, I turn to inferential network tests to assess whether these results correspond to estimated network generation observed in the empirical data, and identify projections resulting from these models.

i. Nodes and Neighborhoods

The simplest starting point for analysis of first-mover advantages in CBDC design begins at the level of *nodes*, which as discussed above are first-mover or responder countries in this network. As discussed above, first-movers and responders are identified here as a function of project initiation, not timing of design announcements. While, no feature of the data measurement favors first-movers to announce design features earlier than other countries, there is a key assumption underlying the possibility of first-mover advantage in CBDC design diffusion which exists at the level of the node: namely, that countries whose projects began earlier are also countries which announced design features earlier. This assumption sees strong support in the empirical data, with first-movers announcing design features approximately 15 months earlier than later-moving countries, on average. This serves as a critical foundation for assessing other node-level outcomes, especially popularity.

A simple approach to assessing popularity in social networks is *centrality*, which are index measures of nodes' connections within a network. The most simply measure is degree centrality, which counts the number of connections to (in-degree) and from (out-degree) a node in the network. In this case, these respectively measure the rate at which countries send or receive design choices in the network. For example, an in-degree measure of 0 indicates a country which announced its particular design features before any others adopted those choices, as there would otherwise be an edge directed *in* from the previous node's shared choice. In contrast, an out-degree measure of 0 indicates that a node, regardless of its in-degree, is the most recent adopter of a design feature in the observed network.

In line with theoretical expectations around first-mover advantages in CBDC choice diffusion, first-mover countries have significantly higher out-degree scores than later-moving countries. Indeed, first-movers have a significantly higher average out-degree score of 12.7, about double that of responding countries, which averages at 6. While there is no significant difference across the groups' in-degree scores, first-movers have a 50% lower average (6.9) as compared to responders (9.5). This suggests that, while both groups are liable to make choices which other states' have made before them, first-movers are disproportionately likely to make choices which other states later adopt. This is a key foundational feature of first-mover advantage as defined in the preceding theoretical framework.

These results are further supported by comparison of the groups' ratios of in- and out-degree to their total count of connections. Whereas in-degree connections are only 35% of first-movers' ties, on average, these account for 60% of responders' ties; the reciprocal also holds, with first-movers' connections disproportionately being out-ties (65%) as compared to the proportion for responders (40%). In yet simpler terms, we can also compare the rate at which nodes' out-connections outnumber their in-connections. First-movers significantly more often have more out-ties than in-ties, at 78.6% compared to 29.6% of responders. As such, we know that first-movers are primarily senders, and responders primarily receivers.

Beyond simple connection counts, other popularity scores also indicate that first-movers disproportionately propagate design choices as compared to later-movers. While degree centrality comparisons are helpful for blunt assessment of differences in general connection trends, other measures help to assess structural features of popularity which pertain to first-mover advantage. Key among these are local triangles, hub scores, and authority scores, which respectively measure nodes' positions in local triangle structures of edges, and their positions as hubs or spokes in star structures within the network. High hub scores indicate a node with many out-ties to nodes that have many in-ties; conversely, high authority scores indicate a node with many in-ties from nodes that have many out-ties.

As with the simple degree results above, we see similar patterns with triangles and hub and authority score differences between first-movers and responders. First-movers inhabit significantly more local triangles, approximately 40% more than responders. First-movers also have significantly higher average hub scores (0.54) as compared to responders (0.27), indicating a significantly higher likelihood that first-movers act as central nodes in star structures. However, responders have only an insignificantly higher average authority score (0.48) than first-movers (0.3), indicating that spokes in these star structures include both first-movers and responders at comparable rates. These scores are summarized in table 5.1, including t-test results for each group's average, the difference, and the statistical significance.

Table 5.1: Node Score Comparisons: First-Movers and Responders

Measure	Responder	First Mover	Difference	P-Value
Degree (Total)	17.3	21.36	4.06	0.09*
Degree (In)	10.7	6.71	-3.99	0.06*
Degree (Out)	6.59	14.64	8.05	0***
Sender (Out >In)	29.63	78.57	48.94	0***
Triangles (Count)	106.56	141.86	35.3	0.13
Hub Score	0.27	0.54	0.27	0***
Authority Score	0.48	0.3	-0.18	0.05**

This evidence strongly suggests that first-movers indeed propagate design choices at a substantially higher rate that responders, and that first-movers also disproportionately inhabit roles as hubs in star structures within the network. In line with theoretical expectations, these results also suggest that first-movers have distinct patterns of connection in the network which should also vary along the level of nodes' local neighborhoods. Specifically, the rate of heterophily among nodes in each group should theoretically be distinct, with first-movers exhibiting more out-group ties (heterophily) than in-group ties (homophily).

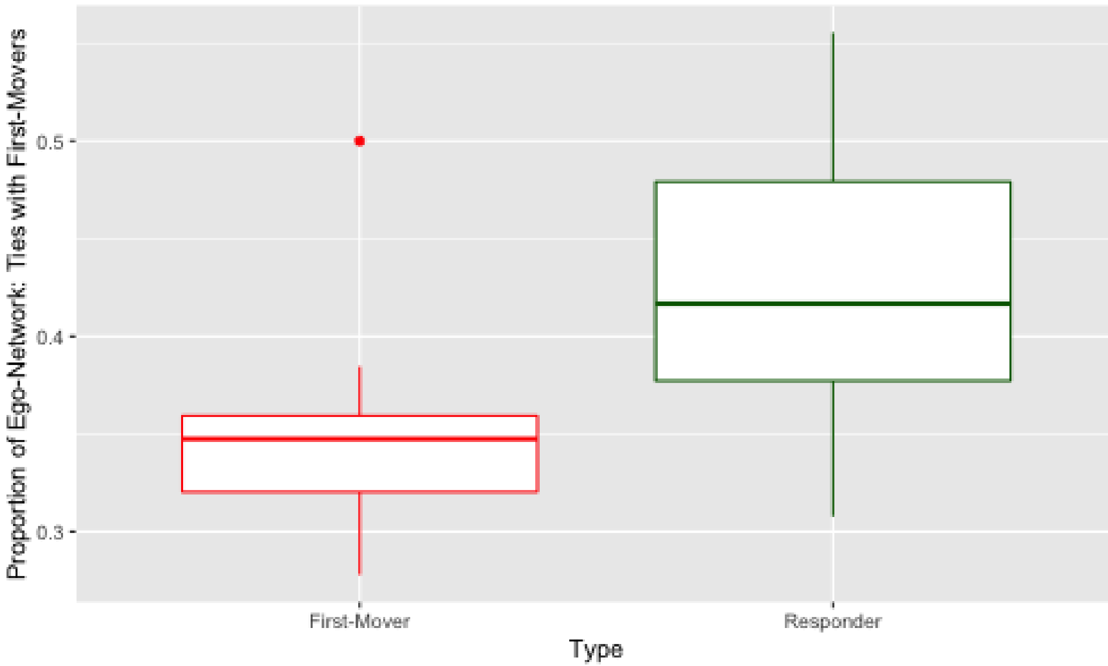
At the level of the full network, we can measure these phenomena with three basic indicators: the share of ties between first-movers, the share of ties between responders, and the share of ties which connect first-movers with responders. The network includes 316 directed connections between nodes, of which 169 (53.5%) are between first-movers and responders. Per the evidence above, we know that these disproportionately originate with first-movers and point to responders due to the disparity in these groups' degree scores.

Among internal ties, responders exhibit significantly higher degrees of homophily as compared to first-movers. Of the 147 within-group edges, 94 (63.9%) are between responders while only 53 (36.1%) are between first-movers. In simpler terms, a randomly selected tie from this network has just under a 50% chance of being homophilous, and among randomly selected homophilous ties in that subsample, it is almost two times as likely to be among responders. This evidence further suggests that first-movers have significantly more heterophilous ties - serving as propagators to responders - as compared to responders, which more often propagate decisions more homophilously within their own group.

Beyond the full-network analysis, we can also compare the composition of each group's neighborhoods. In line with expectations on homophily and heterophily in tie formation, we should expect first-movers' neighborhoods to have significantly lower counts of other first-movers, whereas responders should exhibit a higher proportion of ties involving first-movers. In line with the above results on heterophilous tie formation among first-movers, we see similar results with ego-network composition. First-movers have neighborhoods which are primarily composed by responders, with an average of 61% of their ego-networks composed of ties with responder countries. Conversely, responders have an average of 48% of their neighborhoods composed of ties with first-movers, with approximately half of responder countries exhibiting neighborhoods that are 50% or more first-movers. By contrast, only 7% of first-movers have neighborhoods that are 50% or more fellow first-mover countries. Figure 5.3 below exhibits the cross-group distributions of ego-network composition defined by the proportion of ties with first-mover countries for visual interpretation.

In summary, evidence at the level of nodes supports initial assumptions about first-mover advantage in CBDC design choice diffusion. Countries whose projects began earlier are also earlier announcers of design features, supporting the first assumption necessary for this advantage to hold. Furthermore, first-movers are also disproportionately more likely to have other countries adopt those designs after they have been announced, supporting the second key assumption regarding the propensity for first-movers' choices to propagate more than others'. Beyond this discrepancy in propensity for choice propagation, evidence also shows that first-movers exhibit unique qualities of ties and positions within the network, serving

Figure 5.3: Comparative Ego-Network Composition of First-Movers and Responders



inordinately as hubs and significantly more often propagating choices outside of their group class as compared to later-moving states. This evidence suggests that first-movers enjoy unique functional roles and structural privileges, which is the focus of the next section.

ii. Functional Roles and Structural Privileges

While evidence at the node-level helps to understand countries' individual positions and popularity in the network of CBDC choice diffusion, there are limits to inference at this level with regard to first-mover advantage. As noted in the preceding theory, first-mover advantage also implies particular functional roles for first-moving countries, and by extension, unique structural privileges arising from those functional roles. Again, we can approach these features from two levels of analysis: meso-level functional roles in brokerage positions, and macro-level functional roles in similarity of nodes' in- and out-edge distributions.

At the meso-level, the most salient functional roles for nodes in a network involves their brokerage position. Simply, this refers to the ways in which nodes facilitate directed ties spanning two other nodes that are not immediately connected, as explored in the preceding theory section. As explored in the theory section, brokerage roles imbue important structural privileges to nodes based on the different positions they inhabit with regard to node types, in this case first-movers and responders. As discussed earlier, If first-movers genuinely enjoy and advantage in CBDC design diffusion, we should more often see first-movers in gatekeeper and itinerant roles, and more often see responders in representative and coordinator roles.

In order to identify these two-paths and related brokerage positions, I create an extended edgelist as a function of the original dyadic dataset described previously. For each directed diffusion tie emanating from country A to country B, I identify all out-ties which point from B to any other country in the network excluding A. Each pair thus incurs its own extended edgelist of two-path ties, which are compiled across the full network for a census of all two-paths and their constituent brokerage position. The final two-path dataset is then recoded with identifiers for whether nodes are first-movers or responders.

The observed network strongly supports these expectations for cross-group brokerage positions. First, the census of brokerage positions by broker group affiliation is descriptively in line with theoretical explanations, with 79.7% of all broker positions exhibiting the expected patterns of group assignment. Table 5.2 below reports the disaggregated share of all brokerage positions across group types and across position types (the total of all values in the table sums to 100% of all observed brokerage positions). The bottom row includes a ratio coefficient for the theoretical expectations regarding these roles; this divides the observed share of each position inhabited by the theoretically expected group by the share inhabited by the theoretically unexpected group. In each case, a value over 1 indicates alignment with theoretical expectations where a value below 1 indicates departure from theory.

Table 5.2: Brokerage Role Comparisons: First-Movers and Responders

	Coordinator	Gatekeeper	Itinerant	Representative	Total
First-Mover	4.78	3.44	13.24	20.81	42.27
Responder	17.87	27.74	7.38	4.74	57.73
Expectation Magnitude	3.74	8.06	1.79	4.39	-

As is evident in the table, all observed role assignments are in line with theory. This difference is somewhat marginal for the roles where expectations are based on homophily or heterophily, as in the case with responders as coordinators and first-movers as itinerants. However, the difference is significantly more pronounced for the roles with clearer expectations around structural privileges, especially with responders as representatives and first-movers as gatekeepers. In all cases, though, the difference in relative likelihood that either group inhabits theoretically expected positions is significant with p-values below 0.001.

At the macro-level, we can identify structural features of first-mover advantage by considering functional roles across all connections in the network, rather than only at the level of two-paths. Here, we can consider the structural similarity and dissimilarity among nodes' patterns of ties to inductively identify groups of nodes which act similarly within the network. The process of hierarchical clustering takes two steps. First, the network data are converted to a distance matrix, which measures the matrix distance between all nodes as a function of dissimilarity in the matrix of observed ties among all nodes in the network.[6] Second, a

[6]While a wide variety of distance estimation methods exist, the most commonly applied method for

threshold is identified which 'cuts' the hierarchical dissimilarity distribution to produce clusters of nodes with dissimilarity scores below that threshold.[7] The final result of the process is a set of cluster identifiers for each node in the network based on the communities produced from the selected dissimilarity threshold and patterns of internode similarity.

Here again, the observed data are in line with theoretical expectations. Notably, no other higher count of clusters produces groups which can be meaningfully compared, as a $k > 2$ community structure produces groups with as few as four nodes, serving as validation for the $k = 2$ cluster modularity. The clustering divides the network into two groups of respectively 17 (cluster 1) and 24 (cluster 2) nodes. Notably, the cluster assignment is significantly different from randomly dividing each group across each cluster; 30% of responders are assigned to cluster 1 and 70% of responders are assigned to cluster 2. Indeed, fewer than 10 actors from each group of countries is assigned to a different cluster than the rest of their in-group peers, suggesting strong support for the macro-level positional differences in the functional roles played by these groups. Table 5.3 below reports the representation of each group within each cluster, with rows summing to 100%, the total of each cluster.[8]

Table 5.3: Hierarchical Clustering Assignment Outcomes: First-Movers and Responders

	First Mover	Responder
Cluster 1	52.94%	47.06%
Cluster 2	20.83%	79.17%

Notably, there is clear group sorting into each cluster, suggesting on average that first-movers and responders indeed exhibit structural differences in their patterns of ties and functional roles within the network. In line with the evidence here, responders are significantly more homogenous in their functional roles than first-movers. In other terms, while there are some first-movers which look functionally more like responders, there are relatively fewer responders that resemble first-movers with regard to the pattern of ties.

Indeed, as edges in this network are defined as a funciton of CBDC design choice, we can compare these groups along the degree to which their choices are status quo (score of 0), hybrid (score of 1) or highly radical (score of 2), averaged across all three design choices for each node. A fundamental feature of the theoretical premise, based in existing research on CBDC design choices, is the correlation between early movement and more radical design features. A simple comparison of groups' choice scores across clusters shows that the discrepancy in group sorting by cluster can be understood as error in this fundamental correlation. As shown in table 5.4 below, the few responders which are assigned to cluster 1

hierarchical clustering is Ward distance, which served as the estimator method for this analysis.

[7]Hierarchical clusters can be 'cut' either with a theoretically specified dissimilarity threshold or with a theoretical count of k clusters. The latter method is applied in this analysis given theoretical expectations.

[8]The disparity in table 5.3 column sums is due to the fact that fewer nodes in the network are first-movers, in line with the theoretical categorization by trade exposure, as compared to responders..

have significantly more radical design choices than the majority of responders which were assigned to cluster 2. Similarly, the few first-movers in cluster 2 have design features more closely resembling most responders, and less like their fellow first-movers in cluster 1.

Table 5.4: Design Score Comparison by Clusters: First-Movers and Responders

	First Mover	Responder
Cluster 1	1.5	2.06
Cluster 2	0.3	0.89

In summary, these results suggest that first-movers inhabit unique functional roles in the network and enjoy unique structural privileges associated with these roles. In meso-level structures, first-movers enjoy unique brokerage positions which facilitate in the propagation of their design features, leaving responders in primarily defensive postures from a structural vantage point. In macro-level roles, we see that first-movers and responders sort cleanly into distinct clusters as a function of the dissimilarities in their full patterns of edges. Where this group sorting into clusters defies expectations, we see that this can be in part attributed to deviation from group-level expectations regarding the content of state choices. In total, this evidence compounds the results from the node-level analysis and supports theoretical expectations of first-mover advantage in CBDC design diffusion.

iii. Simulations to Assess Uniqueness

While the evidence provided in this chapter offers compelling support for the theoretical possibility and correlates of first-mover advantage in CBDC design diffusion, there remain questions about the collinearity of this evidence with measurement strategy and prior assumptions. In simpler terms, these results may be idiosyncrasies of the measurement strategy employed in this chapter, which would diminish the power of this evidence in adjudicating on the possibility and presence of first-mover advantage in CBDC design diffusion.

I conclude the results section with a series of network simulation exercises to test two potential concerns with these results. These simulation exercises address two potential concerns around structural endogeneity with the presented results: node dependencies and edge dependencies. On one hand, it is possible that we might observe this set of structural evidence with any configuration of nodes or edges; this would imply endogeneity of the results with the measurement strategy employed in the chapter. On the other hand, we may be concerned that the results are not explicitly attributable to the measured edges and may instead be a byproduct of other aspects of the network.

In order to address these concerns, I present the results of two large-scale simulation exercises which respectively vary the node and edge structure in the observed network. The first simulation approach randomly reassigns nodes within the network while maintaining the observed network structure, in order to assess whether edge dependencies produce the observed results. The second simulation approach randomly samples a probability value between 0 and 1, which serves as a 'confidence coefficient' for the observed network. This value is applied to all observed and unobserved ties in the network such that observed ties (previously a value of 1) take the confidence coefficient value, while unobserved ties (previously a value of 0) take the inverse value of the coefficient. Each simulation then samples the probability of ties based on this confidence coefficient and samples a 1 or 0 simulation value from the binomial distribution relying on this transformed value as a tie probability. For example, if the sampled coefficient is 0.75, observed ties have a 75% chance of being re-simulated, and unobserved ties have a 25% chance to be simulated.

These approaches allow for two assessments of structural endogeneity in the results. First, these results allow for assessment of how structurally unique the observed features of the network are against either simulation outcome. As shown in table 5.5, the values observed in the measured network are significantly unique from all simulated network observations, with absolute t-values in double digits for every piece of evidence supporting the theory of first-mover advantage in CBDC design diffusion. For interpretation, values in the Observed column indicate the difference in scores across first-movers and responders. For homophily, this is the difference in proportion of internal network ties for each group, and for ego-network this is the difference in proportion of each group's neighborhood composed of first-movers. Brokerage expectation measures the proportion of two-paths which meet theoretical expectations, and the cluster values respectively measure the difference between proportions of each group in each cluster, which is 0 when a group is evenly divided across clusters.[9]

Table 5.5: Observed and Simulated Network Evidence Comparisons

Measure	Observed	Probabilistic	T1	Random	T2
Degree	4.060	0.010	49.820	-0.050	56.96
In-Degree	-3.990	0.010	-50.900	-0.040	-57.55
Out-Degree	8.050	0	54.290	-0.010	106.67
Sender Rate	0.490	0.010	42.460	0	91.15
Triangle Count	35.300	4.970	47.410	-0.200	51.31
Authority Score	0.270	0.020	57.260	0	100.36
Hub Score	-0.180	-0.020	-62.080	0	-61.21
Homophily	-0.220	-0.310	-195.260	-0.320	-127.81
Ego-Network	-0.080	-0.030	-107.200	-0.020	-61.21
Brokerage Expectation	75.640	66.530	699.420	65.720	452.82
First-Mover Cluster	0.200	0.210	48.130	0.200	-
Responder Cluster	0.140	0.140	45.800	0.140	-

[9]Note that this comparison does not exist for the node reshuffling procedure as cluster assignment is identical in all simulations due to its reliance on the edge distribution, which is held constant.

These results strongly suggest that the evidence presented here is unique as compared to a battery of random simulations. While these tests cannot address the endogeneity associated with the theoretical foundations of network measurement, they importantly distinguish that the observed network and the evidence measured to test theoretical expectations of first-mover advantage are not simply byproducts of the estimation strategy employed in this chapter. Notably, future work should employ more refined tools like stochastic actor-oriented models to address the multivariate inputs necessary for a holistic test of the underlying theory of edge generation and its implications for the structural measurements in this paper.

5.6 Conclusion

This chapter has developed a theoretical framework to identify the necessary preconditions for and structural evidence of first-mover advantage in CBDC design diffusion. In addressing a contemporary policy question which is evolving in real-time, this research has expanded literatures on both policy diffusion and first-mover advantage to reconceptualize their position in traditional directions of inference. In this respect, and in intersection with theories of structural power at the interstate level, the chapter has significantly contributed to the study of choice diffusion across state lines and offers a framework for identifying first-mover advantage in these situations. The results presented here, derived from social network analysis on large and original data of CBDC design diffusion, suggest strongly that the preconditions exist for first-mover advantage in this context, that there is evidence this advantage exists, and that this evidence is not a random or probabilistic byproduct of node or edge dependencies.

In extending literatures on diffusion and first-mover advantage, this chapter has paved extensive lines for future research. First, future work should extend this framework to other substantive areas of interstate choice diffusion to identify generally understudied issues of structural first-mover advantage in other policy arenas. Relatedly, future work should expand the methodological toolkit applied to this theoretical framework, specifically with integration of more refined network analytic tools like stochastic actor oriented modeling and exponential random graph models, which can better approximate the strategic process assumed to underlie the generative principles of this observed network. Finally, future work should naturally expand this analysis in the domain of CBDC design diffusion, especially as further choices are proposed by states and other modes of first-mover advantage become evidence, such as changes in trade and investment flows or other cross-border outcomes.

Beyond academic extensions, these results have clear policy implications. Simply, there is evidence that first-movers enjoy a structural advantage in CBDC design choice diffusion. Countries should not assume there is no cost to waiting in this respect, and by extension, should be prepared to expend greater diplomatic resources to recover the costs associated with waiting if this was and remains to be their choice, as with salient cases like the United States. Furthermore, these results provide cautionary evidence for central banks which assume a static cooperation environment. As prior evidence on CBDC design choices points strongly toward domestic conditions as a parallel driver to interstate similarity pressures, slower-moving central banks should not underestimate the implications of cross-country alignment in domestic conditions as a potential disruptor to traditional patterns of inter-central bank policy coordination. Coordination alliances may be more fragile than expected, and the rate at which CBDC design choices are made suggests that privileged positions in coordination networks may rapidly deteriorate without careful foresight by decision-makers.

This chapter represents a first test in moving beyond hypothetical and normative discussions on first-mover advantage in the race for CBDCs, and offers a concrete empirical design for exploring the structural patterns of choice diffusion in a rapidly-moving issue area. As this issue continues to grow in real time, the implications of this strategic domain will become clearer and potentially more consequantial to academics and policy-makers alike. In combining a theoretical expansion of policy diffusion and first-mover advantage literatures with a methodological contribution of network analysis for measuring structural advantage, this chapter hopefully offers a wide springboard for future work to develop and refine this approach and these findings in the coming decade of work on CBDCs.

Chapter 6

The Future of Fiat

6.1 Global Politics and Digital Money

The future of fiat money, while uncertain, will likely rhyme with its past. As governments across the world have raced to develop central bank digital currencies (CBDCs), they have extended a long history intersecting politics with the technology of money. This history – by no means over in this most recent technological shift – has shaped much of the strategic interaction among governments in their CBDC progress and design. Much like in all prior recorded instances of change to the technology of money, it is clear that economic inefficiencies alone will not dictate the outcomes associated with today's transition to digital currencies. Rather, as has been historically the case, today's policy juncture around the technology of fiat money deeply implicates global balances of power and clarifies how long-standing channels of international subordination and vulnerability produce distinct incentives around whether, when, and how to develop a digital fiat currency.

This dissertation has offered a systematic first analysis of the global politics inherent to digital fiat money. Beginning with a typology of digital currencies that have emerged in the years since Bitcoin's inception, the dissertation centers CBDCs as a unique instantiation of novel monetary technology which responds to both the economic inefficiencies of prior models and the political structures in which today's decisions are nested. The following chapter detailed a unique theory to explain two primary outcomes in central bank digital currency development: the timing of projects and the design choices governments prefer. Building on existing literature that highlights domestic conditions associated with these outcomes, my theoretical framework includes these baseline considerations under a more expansive framework centered on the domestic and global factors that either align with or update existing government preferences for their sovereign money.

The three empirical chapters in this dissertation presented systematic tests of this theoretical argument on a new, large dataset of CBDCs across the world. Built from existing repositories, and significantly expanded with extensive primary and secondary source evidence, these data stand as the currently most extensive accounting of governments' public signals about their CBDC project timing and design anywhere in the world today. The data include not only extremely granular measurement recorded at the country-month level; they also include variables such as publicly stated motivations and project targets.

Relying on these new data, the dissertation showed strong support for each empirical outcome theorized in the aforementioned framework. First, statistical results strongly suggest that countries with greater political and economic subordination in global networks of interstate relations are significantly likelier to move first in CBDC design, and to pursue more radical design choices than other countries. Second, these results strongly support my theoretical expectations that those early and more radical choices produce important spillover effects that respectively accelerate other countries' projects and encourage alignment in pairwise design choices among projects. The final empirical chapter demonstrates that the combination of these results provides structural first-mover advantages to countries whose projects began sooner, evidence which supports contemporary discussions on whether to move quickly or accurately in this space and supporting the narrative of a digital money race with careful theory and empirics that are lacking from current discussions.

These results constitute a significant contribution to the fields of international relations and political economy. In extending long-standing literatures on the global politics of fiat money, this work has brought the global political economy of monetary decisions into the 21^{st} century. Not only has this work been conducted in real time, posing both unique opportunities and challenges for measuring CBDC developments at scale; it has also offered unique insights that span beyond the academy. Based on these results, this chapter proceeds in the following sections. I first briefly discuss the policy implications associated with my broad results on strategic interaction in central bank digital currencies – unique from the specific implications identified in each chapter – and point to the important decisions that government actors will make in the near future that are involved with this dynamic. I then discuss future research in this general area of political economy – again at a level spanning beyond the next steps for work identified in each chapter – including extensions to empirical data and statistical analysis. I conclude the chapter with a brief discussion of likely future trends in the domain of digital money more broadly.

6.2 Policy Implications

Policy makers cannot proceed with CBDC development under the illusion that their choices are independent of those made in other countries. Rather, as with virtually all policy-making around issues of fiat currencies, central bankers and related regulators must remain attuned to the global interdependencies between their economies and others as they decide whether, when, and how to build a CBDC. While this research has not offered any conclusions on whether a CBDC is a prudent policy pursuit, it has demonstrated the many costs associated with waiting. Not least among these are the structural constraints associated with beginning work later than other countries. In this respect, this dissertation has raised three primary policy priorities for CBDC decision-makers at the domestic, global, and transnational levels.

First, central bankers and regulators must remain attuned to the fast-moving and unique pressures associated with cryptocurrencies in their economies as they develop CBDCs. This is not due to the demonstrated association between cryptocurrency use and CBDC development, which stands as a symptom of this prescription. Rather, as discussed in the theoretical framework for this dissertation, cryptocurrencies are proliferating within economies for reasons that implicate weakness in currencies and financial markets. The key implication of this development is that cryptocurrencies create substitutionary pressures in some countries, and contingent on the nature of economic weakness which they are respectively addressing, those pressures affect distinct classes of political and economic actors in each country.

As such, the policy implication of this dynamic is two-fold. First and foremost, key decision-makers and regulators in countries where cryptocurrencies are proliferating must conduct systematic assessments of the causal forces behind the prevalence of these instruments. These are not uniform across countries. In some countries – especially financially developed countries like the United States – cryptocurrencies are serving as alternative investment outlets that indicate a disequilibrium in financial markets with regard to the balance of risk and yield. In other countries – particularly countries like Turkey or Russia, where rapid currency devaluation has triggered enormous inflation in short time windows – cryptocurrency prevalence may speak to a direct weakness in the fiat currencies of those countries. The true causal forces behind cryptocurrency prevalence are likely more diverse and nuanced, and policy-makers must first identify those reasons before intervening in markets.

Beyond this, central bankers in these countries must consider the degree to which the causes of cryptocurrency prevalence implicate decisions about their respective fiat currencies. In cases where causal drivers of cryptocurrency use are strictly in financial markets, this may suggest that no CBDC design choices would meaningfully address the economic weaknesses to which cryptocurrency use is responding. In cases where cryptocurrency is responding to genuine weakness in fiat money, though, central banks must consider the underlying problems causing this substitutionary pressure and should carefully assess the political, social, and economic trade-offs associated with centering these issues in the technical development of their CBDC. This will be particularly complicated in light of cross-border technical coordination for interoperability, a point explored below, which introduces novel two-level transnational problems that must be considered proactively.

Second, given the myriad and conflicting channels through which spillover effects occur in CBDC development, decision-makers must prioritize their desired trade-offs as they develop CBDCs. Not only should central bankers and regulators remain aware of the economic or political costs associated with highly divergent CBDC models across borders, but they should also be proactive in considering the coordination and cooperation demands that these costs imply. In this respect, central bankers are becoming yet further intertwined into typical patterns and processes of global power expression, and in many cases may have no option but to comply given legal mandates and concerns about political independence perceptions if they choose to defy government legislation mandating CBDC development.

This implies both risks and opportunities to central banks and governments. On one hand, there are clear and present risks regarding the nature of political and economic relationships with other countries that implicate familiar diplomatic negotiation needs in CBDC development. This is particularly true for issues of CBDC design and ensuring interoperability among distinct CBDC projects. However, this need for coordination also suggests unique diplomatic opportunities for decision-makers to leverage in their CBDC work. For example, given the significant interlinkages between currency issues and other policy concerns in political and economic interstate relations, coordination on CBDC interoperability may provide useful hooks to coordinate on other issues in which there might otherwise be greater difficulty finding common ground with counterparts in other countries.

Third and finally, these results point to the likely need for transnational epistemic coordination on CBDC projects in order to that technical interoperability does not come at a severe cost to end-user or broader economic well-being in some countries. On one hand, this policy implication stands as a specific mechanism for the policy implication stated above, as a great deal of interstate coordination on issues pertaining to CBDCs will occur across sovereign central banks. On the other hand, though, this policy implication suggests a unique dynamic of expert cooperation across functionally similar institutions in politically and economically distinct national contexts, suggesting that the most important locations of interstate cooperation are subject to highly unique organizational influences.

This final implication centers traditional issues in international relations and political economy on the role of epistemic communities. Likely, the epistemic community emerging around digital money will play an enormous role in the 21^{st} century global digital economy, as it will determine the specific technical features of the currencies in which contemporary economic exchange is denominated. This specific mechanism of cross-border coordination will also have unique risks and opportunities. As expert communities are liable to view complex issues narrowly, and may turn a particular blind eye to features of the decision space which have been traditionally unfamiliar to those individuals, the likely coordination on CBDCs at the level of central banks suggests a dire need for traditional economists to become intimately familiar with rapidly changing technologies like blockchain. However, as notoriously independent organizations within otherwise politically charged national environments, it is likely that the organizational characteristics of central banks will foster careful, informed, and ideally technically neutral decisions on the future of fiat money.

6.3 Future Research

Beyond the policy implications, this first systematic analysis of strategic interaction in CBDCs raises a wide variety of lines for future research. While this dissertation has offered as wide a view as possible on the global political economy of digital fiat money, it naturally has required a sufficiently narrow perspective to complete in a normative timeframe. As such, the many questions left to answer after this research are critical avenues for future scholarship in political economy at large. These lines of future research can be organized into three general classes of inquiry: (i) the role of CBDCs in the broader digital money ecosystem, (ii) the role of political economic forces in shaping CBDCs, and (iii) the role of

CBDCs in changing dynamics of interstate relations.

The first avenue of future research implicates the technology of digital money more broadly in the power dynamics of domestic and global political economy. This line of research is a direct byproduct of the first chapter in this dissertation, which explored unifying technical features of digital money – including both CBDCs and other forms like cryptocurrencies – and their implications for traditional topics of governance in the field of political economy. Here, there is an enormous set of future research questions which were foregrounded in the first chapter, and briefly reiterated here. Building on the discussion in the first chapter, the next lines of research in this domain can be understood at the intersection of the three critical technical features of digital money and the sorts of actors that those technical features implicate in political economic relations – firms, banks, and governments. Likely, this research will be most successful when focused on particular sectors or constellations of actors associated with the consequences of each digital currency or design feature class.

The second avenue of future research should continue exploring the direct topic of this dissertation: how existing patterns of global political and economic relations shape CBDC development at scale among countries. As I discuss at length in the concluding section for this chapter, there will likely be three general stages of CBDC development: (i) exploration, (ii) experimentation, and (iii) standardization. This dissertation studied dynamics of strategic interaction under an exploratory stage of global CBDC development, and the dynamics of experimentation with actual prototypes and standardization with CBDCs at global scale will be highly unique as compared to the results explored here. In this respect, those future stages of CBDC developments will pose new opportunities for testing the theoretical framework developed in this dissertation, expanding it with relevant developments as the CBDC work progresses, and for updating the empirical data included in this dissertation.

The third and final avenue of future research should consider the opposite causal chain explored here: namely, how CBDCs, once developed and launched at scale, change traditional patterns of interstate political and economic relations. At the time of writing, the nascent stage of CBDC development has meant that there is little to no evidence of effects that would fall into this category of research. However, once CBDCs have been developed and launched at scale – likely within the next decade, given the trajectories detailed in this dissertation and the publicly stated goals of many governments – these instruments are liable to significantly disrupt familiar patterns and processes of interstate relations that fall directly in the purview of international political economy. Here, we can consider three potential outcomes that may be affected by CBDC development and use: the politics of trade and investment with digital fiat money, the strategic cooperation and competition in political agreements that are shaped and constrained by CBDC design, and the transnational logics and processes of expert coordination among central banks across countries.

6.4 Conclusion & Future Trends

The development of CBDCs remains extremely early, and as such, there are years of further developments which require careful theoretical development and empirical analysis to understand and act upon. This dissertation has offered a real-time analysis of CBDC development in its first decade, providing both theoretical insights based on novel empirical data, and a general model for studying this issue into the future. These results suggest three likely trends for the coming decade premised on likely phases of future CBDC development.

First, CBDC development will continue, and likely accelerate, in the coming ten years. This will likely proceed in a series of global phases in which countries respectively operate at unique paces. The phase documented in this dissertation has been *exploratory* CBDC development; at the time of concluding this manuscript, only two CBDC projects are live and neither is a major global currency. In this respect, there will likely be a continuation of this exploratory phase which will culminate in a phase of *experimentation*. This second stage will take place once most viable prototypes are complete and launched for 'sandbox' style testing at home, and will largely consist of finalizing domestic regulatory frameworks for safe use at scale. Intersecting with this final phase will be a concluding third phase of *standardization*, in which countries coordinate on final technical standards and concordant economic and political arrangements to ensure interoperability in global CBDC use at scale.

Second and relatedly, these phases of technical development will correspond with a variable level of tension in global politics of CBDCs. In this exploratory phase, much strategic interaction is premised on regulators' best guesses about the technology and potential of CBDCs. Bluntly, most central bankers know very little at the time of current writing with regard to how they might actually build and launch a CBDC at scale, and many are awaiting legislative mandates to do so. However, the experimentation phase will much more likely be characterized by a more material race to develop a specific kind of digital money; whereas today's race is an abstract expression of vague steps toward technological superiority, the race under experimentation will exhibit a much higher level of specificity in the features and consequences of CBDC design. Similarly, the standardization phase will likely see the greatest level of conflict, as this stage will be the instance in which other issues linked to CBDC consequences – trade and finance – will be clear and create trade-offs for regulators.

Third and finally, we should expect weaponization of CBDCs in the same ways that contemporary fiat money and dual-use technologies are weaponized. As I have argued elsewhere, digital money opens new avenues for cyberattacks on entire economic ecosystems in ways which today's paper cash system do not afford. Similarly, the wide menu of programmable options in some CBDC projects leaves open avenues for attacks – domestic or international – which remain largely unimaginable in today's world. Yet more concerning is the potential for digital currency populism. The same mechanism of programmability leaves open highly concerning pathways for populist leaders to much more significantly warp the design and functions of money to suit short-term political goals. This third and final trend may characterize each phase above in some respects, but stands as a critical consideration for decision-makers as they navigate the near future of digital money. While the potential to weaponize digital money is certainly concerning, the likelihood of success in such attacks hinges on decisions that will be made in the coming years.

Digital money will not develop quietly within borders. Rather, as explored in this dissertation, today's evolution in the technology of government money – the leading economic technology for insuring promises among actors within and across societies – will challenge the global balance of economic power in important ways. It is only through the lens of international political economy that we can understand and measure these global influences, and in the process, work to make the development of digital money a safe, responsible, and productive change in human society.

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