Optimized Payment and Financial Infrastructure under New Technologies: The Case of CBDC

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I-Meeting of Heads of Financial Market Infrastructures

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Premise: Innovative Technologies

❖ We have technologies with enormous innovative potential, real game changers

❖ Technology
  ➢ Ledgers: Bitcoin, blockchain, and distributed ledgers
  ➢ Cryptography: Fully homomorphic encryption and multi-party computation

❖ Much of this is not actually new, but innovations are more frequent and technology is improving

❖ Central Bank Digital Currency (CBDC)
  ➢ As a lead example, revealing
  ➢ Central banks and Bitcoin, at first resistant, and now exploring CBDC

Objections

❖ Hype and exaggeration about DLT, unclear definitions, religious wars

❖ Allure of the technology, but what is the economic role

❖ A technology looking for applications vs. fundamental economics problems, and how do we solve them

❖ We may not need all the pieces together

❖ Individually or in combination, very powerful

❖ What is the motivation for central banks?

  ➢ My premise today: It is not protecting legacy systems

  ➢ Rather, it is to take advantage of innovative potential

❖ However, are there problems coming from private sector solutions being blocked?

  ➢ If so, should deal with that part directly

The Main Theme and Goal

❖ Ex ante optimal design of financial and monetary systems

❖ Hence, a positive talk, in tone and in specifics, here is what we need to do

❖ Corollaries

➤ Financial, monetary, and real are all integrated

o Should not separate motives for trade from payments and settlement

➤ Markets and institutions are "up for grabs"

o Which is why we need those blueprints for where we are going

❖ Featuring: What CBDC is good for and when there are alternatives

➤ Interpreting CBDC broadly

Outline of the Talk

❖ Payment Systems: From Walrasian Bankers, History to Initial Use of CB Tokens, Not So Useful or Efficient

❖ Bills of Exchange to Central Banks: Regulatory Role for DLT/Smart Contracts

❖ From Fast Payments to Shortages, to Remedy: Better Financial Infrastructure with Ledgers and Cryptography

❖ Design of Payments Systems: Ad Hoc Criteria vs. Optimized Economy-wide Design

❖ Goals Of CBDC Payment Systems, Public vs. Private Provision: IO Considerations and When Regulation Is Needed

❖ Public Sector Provision of Payments/Transfers and Insurance: Depends

❖ An Algorithm for Assessment of Financial Infrastructure and Action Plan

❖ Needed Information Infrastructure: Distributed Ledgers as Financial Accounts

❖ Information Infrastructure: CBDC as Database

❖ Monetary Policy with Ledgers and CBDC: Where We Are Headed

❖ Summary and Conclusions

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❖ Historical example: Trade fairs with merchandise

➤ A structured time sequence for trade of goods, some traders buy before sell, have credit on books of bankers, sometimes in ghost currency (no coin), individual budget balance in the end, credits for sales and debits for expenses match

❖ Take aways

➤ Money as unit of account and medium of exchange (not store of value)

➤ Rules agreed to by private/public consortium, as in Bank of Amsterdam and the early bank clearing platforms in London and NY

  o Distinguishing public from private is problematic, need rules of the game and enforcement

➤ If markets/contracts are complete, neither endogenously valued fiat money nor crypto currency are needed

➤ Longer run and larger issue: Are we heading to a virtual e-world, indeed has the future already arrived

  o Valued money as store of value is a tenuous thing, needs to be recognized explicitly and incorporated

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❖ Contemporary example, CBDC

➢ Central bank of Australia issues tokens in exchange for commercial bank reserves at beginning of working day, pay tokens back at the end of day

❖ Take aways

➢ Economics is largely the same in the two applications (if reserves are borrowed)

➢ Lesson: Identify the underlying economics of the situation

➢ Merchant vs. banks, may be a distinction difficult to make, likewise retail vs. wholesale

➢ CBDC not new relative to historical systems and we already have interbank, so not needed

❖ Jasper, MAS, Boston FRB experiments: Ethereum, IBM hyperledgers, Quorem, Corda are clunky and/or not actually decentralized

➢ No magic bullet

➢ "Decentralized ledgers" receive way too much attention

➢ Tail is wagging the dog, other parts of the dog are more promising

Bills of Exchange to Central Banks: Regulatory Role for DLT/Smart Contracts

❖ Historical: Deficit on the books of merchants, solved with written promises to pay at next trade fair, promises circulated as a money

❖ Chaotic conditions in bills gave rise to Bank of England and associated monetary policy: Discounting real bills

❖ An economic analysis: The trouble could well have been a coordination problem

❖ Lessons from monetary theory
  ➢ High velocity private debt, multiple equilibria with informationally separated markets (Townsend and Wallace 1987)
    o If not picked, slow moving disaster
  ➢ The impossibility of decentralized monetary exchange (without records of trades)
    o Need to share trading histories (Ostroy and Starr 1974), not there now
  ➢ Contemporary analogues: Segmented NY repo markets, volatility in the repo rate relative to the policy rate

❖ Coming future attractions: Digital assets with high velocities, need to regulate but not suppress
  ➢ Use the new DLT technology itself

❖ Solution: Distributed ledgers for tracking and coordination, achieved with programed smart contracts, a definite role for CB's (Aronoff and Townsend 2020)

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From Fast Payments to Shortages, to …

❖ Small-valued retail has a common problem: Shortages
  ➢ Common problem in cross-section of environments: M-Pesa Safaricom agents, bank agents in Indonesia, all run out of one object or another or both

❖ If fast payments is achieved for retail, then imbalance is loading onto the wholesale agents, BIS

❖ Same problem with high-valued wholesale payments
  ➢ Broker-dealers in NY

❖ Not surprising: This is what we expect from theory, and this is what we find in practice
  ➢ Flows do not balance

❖ Current situation
  ➢ Informal and undocumented ways to balance, via borrowing and lending, gifts
    o Likely imperfect system
  ➢ Advanced markets, inadequate, sharp price movements in repo, fall back on blunt policy remedies

❖ Design market for credit with insurance contingencies, to deal with liquidity shortages

❖ Specifics: Use homomorphic encryption and multi-party computation to deal with privacy issues and use assets on ledger with smart contracts to effect the requisite transfers

➢ Work in progress, prototypes running or underway (Townsend and Zhang 2020)

o Bids as in auctions kept private without auctioneer

o The liquidity hybrid – borrowing and lending with insurance

o State-contingent sequential service to mitigate runs without revealing history and private information

❖ General principle: Full implementation of solutions to mechanism design problems without a planner

❖ Smart contracts vs. DLT

➢ The multi-agent smart contract can be implemented off-chain, then DLT ledgers used for collateral and ex post value transfers if do not have or trust a third party (the latter also remains an option)

Design of Payments Systems: Ad Hoc Criteria vs. Optimized Economy-wide Design

❖ Example of typical stated goals: 100% completion, no fails, no payment "episodes," support full high volume and fast, instantaneous RTGS

❖ These are ad hoc metrics not recognizing the underlying economic problem, nor achieved in practice either
  ➢ Algorithms to clear as much as possible, but not all, ad hoc
  ➢ Liquidity saving mechanisms and implicit role of central bank, but it is risky, how much liquidity, ad hoc

❖ Lessons from theory for goals and for policy

❖ No fails?
  ➢ If incomplete markets and financial contracts, introduce needed contingencies and an optimized penalty system

❖ Monetary policy: Algorithms for how to inject liquidity based on a new measure of financial centrality
  ➢ Recognizing when markets are thin, who is key on average in maintaining volume, positions in supply chains, inject to these named players ex ante (Chandrasekhar, Townsend and Xandri 2020)
  ➢ COVID-19 policies: A telling strange blend of micro vs. macro
  ➢ "Traditional" monetary policy (interest rates and balance sheets) vs. new market facilities (which may not exist, as for SMEs)

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Goals Of CBDC Payment Systems, Public vs. Private Provision: IO Considerations and When Regulation Is Needed

❖ Industrial Organization motivation for CBDC in payments
  ➢ Worried about exclusive private sector provision of payments

❖ Answer with a question: How competitive can private sector be?
  ➢ Ironic problems with new technologies, scaling up
    o A symptom: off-chain vs. on-chain decisions
  ➢ But then competition among platforms can work
    o Walrasian outcome can be approximated and welfare theorems hold when platforms designed and priced properly (Jain and Townsend 2020)
    o Risk sharing vs. transaction costs deliver multiple segmented clusters in the core optimum (Townsend 1978)

❖ In practice
  ➢ Commercial banks may not innovate, and fin techs not encouraged
    o Deal directly with bad regulation or otherwise CBDC and to induce competition
  ➢ Big tech problem with abuses
    o Cryptography, algorithms to replace third party operator of platforms (Townsend and Zhang 2020)

❖ Limits to competition and needed regulation: Lesson from mechanism design on utility tokens
  ➢ Having fiat money compete against utility tokens can be damaging to incentives
  ➢ Utility tokens should not be exchanged in platforms, undercuts their use

Public Sector Provision of Payments/Transfers and Insurance: Depends

❖ Goal: Provide insurance transfer in pandemic as in COVID-19, and in natural disasters, support to SMEs

❖ In some countries, private systems do this already: Alipay, M-Pesa,

❖ Are there regulatory barriers in countries that have a limited private sector?

❖ Public sector runs a risk: Government absorbs too much risk and also blocks private sector development, subsequently

❖ A way of proceeding: Document what is the actual situation on the ground in a given country and where there are shortfalls

❖ Likely outcome, needs for innovation are there
  ➢ Kinship and relationship lending

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An Algorithm for Assessment of Financial Infrastructure and Action Plan

❖ Townsend Thai project

❖ What is working and what not

❖ Reliance on kinship even within villages, and no infrastructure for cross-village trade

❖ Role for fin techs, with the new technology
  ➢ Evrynet for smart contracts and Lightnet for cross-border transfers (migrant remittances)

❖ Role for public sector
  ➢ Ensure competition for provision of smart contracts with platform design
  ➢ With appropriate ground rules for market structure

❖ Advanced economies

❖ Document and assess reliance on relationship lending limits for SMEs (as in Paycheck Protection Program and MainStreet)

❖ Build SME financial and information infrastructure
  ➢ For objects traded (contracts with contingencies)
  ➢ Securitization
  ➢ Trade platforms (auction and matching)
  ➢ Bring innovations from the literature and cryptography into these designs
  ➢ Facilities for FRB injections not currently available

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Needed Information Infrastructure: Distributed Ledgers as Financial Accounts

❖ Huge role for public infrastructure with private collaboration

❖ Advantage of distributed ledgers: Instantaneous reconciliation
  ➢ Australia stock exchange – for immediate settlement if desired and better data

❖ Bitcoin is example of cash flow and balance sheet

❖ General principle: Integrated accounts for stocks and flows

❖ Example from the US
  ➢ Top US surveys do not meet this standard
  ➢ Integrated financial accounts in the US
    o FRB and BEA recognize the principle but income and balance sheet difference has large errors and omissions
  ➢ Symptomatic: Suffering from same limited data problem
    o Data used in analysis of COVID-19
    o Data used in measuring inequality
    o Income and balance sheet discrepancies, or have one and not the other

❖ Action plan
  ➢ Households and SMEs: Electronic data to construct accounts
  ➢ Supplemented with collaboration with FRB and BEA
  ➢ Larger firms and financial institutions – confidential data sharing through MPC
  ➢ Recognize data science principles for synchronous and asynchronous data, trade offs
    o Consistency vs. availability

❖ US just an example: These steps can and should be followed in other countries

Information Infrastructure: CBDC as Database

❖Already emerging implicitly with CBDC

❖China: PBOC has decided to use a value-based, semi-account-based and account-based hybrid payment instrument. Identity would be based on "loosely coupled account links" with counterparts in daily transactions. Submit transaction data to the central bank via asynchronous transmission on a timely basis (Fan 2020).

❖Sweden: Intermediaries are responsible for KYC and ongoing due diligence for each and every CBDC user

  ➢ Riksbank only receives information on individual account balances and payments, but not information on the actual account holders

❖Innovative cryptography is needed given design objectives

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Monetary Policy with Ledgers and CBDC: Where We Are Headed

❖ Transactions data are micro data, kept on ledgers

➢ Reveals patterns of exchange and hence role of money

❖ Monetary policy can and should be based on this, ultimately

❖ True for fiat, as per the liquidity injection discussion, and for crypto-currency in self-contained systems

❖ Macro policy rate vs. micro facilities: Need new conceptual framework

❖ As financial infrastructure evolves with public or private innovation, anticipate so will optimal monetary policy

➢ Think long term

❖ CBDC with ledgers and smart contracts offers the advantage of algorithmic design for commitment and forward guidance

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Summary and Conclusions

❖ CB tokens do not dominate historical or contemporary interbank systems

❖ Very useful regulatory role for DLT/smart contracts for coordination and information, segmentation problems

❖ Fast payments will bring shortages but also a remedy: Better financial infrastructure with ledgers and cryptography

❖ Design of payments systems: Ad hoc criteria are dominated by optimized economy-wide design

❖ Public vs. private provision: IO competition vs. big tech, but also regulation needed when cryptocurrency and fiat money are not substitutes

❖ Public sector provision of transfers and insurance – it depends

❖ An algorithm for assessment of financial infrastructure and payments systems, then onto implementation: Action plan (how to actually do it)

❖ Information infrastructure: CBDC as database, quite important

❖ Monetary policy with ledgers and CBDC: New conceptual framework needed as evidenced by response to shocks and pressures on CBs to respond