Cryptocurrencies, Fintech, and All That: Monetary Economics in the 21st Century

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Motivation

• In any given day, you might read about:

1. Cryptocurrencies.
2. Central bank digital currencies.
3. The blockchain and other distributed ledgers.
4. Tokenization.
5. Smart contracts.
6. Fintech.
7. ...

• Furthermore, you can even encounter all these new developments in your daily life.
Questions

- What do all of these new developments mean?
- How should we think about these new topics from the perspective of monetary economics?
  1. Positive economics.
  2. Policy advising (national and global).
- Of course, a fair treatment of these topics will require (at least!) a whole semester. Thus, I will be highly selective in my discussion.
- Notice: different (although not unrelated!) from perspectives in computer science, microeconomics, law, and business.


- **Central Bank Digital Currency: Central Banking For All?**, NBER WP 26753.

Structure of the talk

1. I will first briefly review why money is the memory of society.

2. I will use that framework to think about private cryptocurrencies (with a coda on blockchain).

3. I will analyze central bank digital currencies.

4. I will offer some concluding remarks.
Money is memory
Why do we use money?

- Money is one of the most remarkable inventions of humankind.

- It solves a fundamental challenge of any society that relies on the division of labor: the “double coincidence of wants” problem.

- A simple example:
  
  1. Every fall semester, at Penn, I teach “Global Economic History.”
  2. Students want to take my class.
  3. But the students do not produce anything I want.
  4. For example, I want to buy a bottle of milk (and possibly, on another day than the day of my lecture).
  5. Hence, barter is not a realistic solution except in a few exceptional cases.

- In other words, trade is subject to frictions. These frictions are “essential.”
How can we get around trading frictions?

1. We can assign goods in society through a central planner. Works in small groups (e.g., a family, a small hunter-gatherer band), but this system cannot be scaled up due to informational problems.
   - Experience of the Soviet Union (and, no, AI will never fix this problem).

2. We can conduct all transactions simultaneously in a centralized market à la Arrow-Debreu.
   - This trading arrangement is fruitful for answering many questions of interest in economics, but it is not realistic: logistic costs would be too high.
   - Problem of enforceability.

3. We can keep a ledger where each member of society would write their production (or received transfers) as positive balances and her consumption (or negative transfers) as negative balances. My experience of a spring break trip when I was in college.
   - Again, the problem of scalability.
   - But there is an intuition here we might be able to exploit.
A better ledger

• Usually, we do not need all the information in the ledger.

• If we are willing to accept “finality,” we only need to keep the current balance in the ledger.
  • It can be implemented as a “balance of gifts.”
  • Or in terms of tokens.
  • *Rai stones*, the traditional money employed on Yap Island.
  • Some underwater!

• Advantage of tokens: you can run a decentralized system without a central bookkeeper. Informationally much more efficient.

• In other words: money is the memory of society! (*Kocherlakota, 1998*).
A working definition of money

1. Because of the division of labor, we need to trade among us.

2. Trade through barter is unfeasible, in particular intertemporal trade.

3. Societies work around this problem by having a decentralized net-balance ledger system expressed in tokens.

4. We call these tokens “money.”

A working definition

Money is an informationally efficient recordkeeping mechanism to allow for decentralized trading under essential frictions.
A few implications

- In this definition, money is a medium of exchange and store of value (both are, actually, the same: intra vs. intertemporal trade), but not necessarily a unit of account (Livre Turnois).

- Different assets have different degrees of “moneyness.”

- Money is created every time we engage in a decentralized ledger.

- Whoever says money, says trade frictions: we cannot assume, by default, that welfare theorems are going to hold or that we will have unique equilibria.
La Banque promet payer au Porteur à vue Cent livres Tournois en Especes d'Argent, valeur reçue. A Paris le premier Janvier mil sept cens vingt.

Vü p. r le Sr Fenelion.

Signé p. r le Sr Bourgeois.

Controllé p. r le Sr Durevess.
GOL
CAMPEONATO DE LIGA
1984/85
R. MADRID 35

DELANTERO
SANTILLANA
Carlos Alonso González
Nació en Santillana del Mar (Cantabria)
el 23/8/52
HISTORIAL DEPORTIVO
Racing, Real Madrid.
How do we organize this recordkeeping mechanism?

- Just a few questions:

  1. Who should issue the tokens?
  
  2. What is the form of the tokens?
     - In particular, should the token be intrinsically worthless or incorporate some value (such as a precious metal)?
     - In what denominations?
     - How do we make it durable, and easy to store and transport?
     - How do we warranty that it is readily recognized and not a forgery?
  
  3. Who receives the initial endowment of tokens?
  
  4. How many tokens are socially optimal?
  
  5. And when should we issue them?
Public vs. private monies

- Notice that nothing that I have said so far requires money to be issued by a government.

- In fact, money started as being “private”: commodity monies.

- Coinage was only taken over by the government later in the development of money.

- Current government money is nothing more than consols with zero nominal coupon.

- Saves on the use of commodities, allows for control of inflation, and the creation of liquidity when needed.

- This observation motivates the fiscal theory of the price level and why there is a Laffer curve of seignorage.

- “Legal tender” does not mean much (“Swiss dinar”).
Pellofas from La Seu d’Urgell and Peramola
Cryptocurrencies
Historically, technology has been a key determinant of how we organize money.

Somewhat surprisingly, interaction between technology and money takes a back seat in most textbook expositions of money:

1. Invention of writing.


3. Invention of paper.
The arrival of cryptocurrencies is, therefore, one more step in the interaction between technological change and money:

1. Computer networks have changed the logistics of distribution of private monies (separation from banks)
2. Cryptography techniques prevent over-issuing, the double-spend problem, and counterfeiting.
3. Possibility to automatically implement contingent contracts.

As of October 29, 2020, we have 21 crypto-currencies with market caps over $1 billion.

The largest, Bitcoin, has a market cap of $250 billion (a bit more than Toyota).

Bitcoin is fully fiduciary (even more so than public monies!).
An intriguing phenomenon

- Active competition among privately-issued currencies.
- Not seen since the end of free banking (Scotland in 1844, the U.S. in 1863).
- Although free banking was a different institution: cryptocurrencies perhaps closer to commodity money that uses an intrinsically worthless standard.

  1. Private markets can implement desirable outcomes, even in the field of money.
  2. Privately issued currencies can deliver price stability.
When Lagos-Wright met Hayek
Questions

- Will a system of private money deliver price stability?
- Will the market provide the (socially) optimum amount of money? Probably no.
- Will one currency drive all others from the market? Or will several of these currencies coexist along the equilibrium path? Long-run competition is likely.
- Do private monies require a commodity backing? No.
- Can private monies and government-issued money compete? Yes, but competition changes what monetary policy can do.
- Are network effects important? Yes, but in subtle ways.
- Are security risks significant? Yes, Goldfinger attacks.
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A short coda: the blockchain

- Nothing I have said before deals with the blockchain.
- But, in some sense, we have already worked out what the blockchain is: a distributed ledger.
- A fundamental problem of (nearly) all economic activities is the verification of conditions:
  1. Who is the owner of this building?
  2. Has a package being delivered?
  3. What do we have in a depot?
  4. What is the balance on my checking account?
  5. Have I paid my HOA this month?
  6. How many teaching credits do I have in my department?
- Related versions of this problem appear in the control of industrial processes (e.g., avionics), but we can skip them today.
Consequences

- Difficulties in verifying conditions prevent (or make it too expensive) economic transactions.

- In fact, the systems of private law are designed (or should be designed) to facilitate verification (and its finality) and, therefore, maximize exchange and surplus.

- A common solution is to have centralized verification systems composed of three elements:
  1. A ledger.
  2. A bookkeeper.

- Example: a land registry.
Problems with centralized systems

1. Require trust in the bookkeeper.

2. They are expensive.

3. They are slow and suffer from latency delays.

4. Not very flexible.

5. They limit the adoption of new technologies.

6. Cases where they cannot be applied.
Can we design decentralized verification systems?

Potentially faster and more powerful (smart contracts, automatic regulation).

In fact, we already use decentralized systems:

1. Fiduciary money.
2. Email (SMTP).

Continuum of centralization vs. decentralization, with plenty of mixed systems.

Blockchain is a decentralized system with verification by consensus.
Proposed by Lamport, Shostak, and Pease (1982):

1. Several divisions of the Byzantine army camped around a city.
2. Each division commanded by a different general.
3. The generals must agree on an attack plan (for instance, attack in the morning or in the afternoon).
4. The generals can only communicate through messengers.
5. At least one of the generals might be a traitor.

We look for a mechanism:

1. Ensures loyal generals agree on a common plan.
2. Avoids adopting a bad plan because of traitorous generals.
Some bad news and some good news

- Problem does not have a solution if at least $1/3$ of generals are traitors.

- The Fischer-Lynch-Paterson (FLP) theorem: impossibility result for asynchronous deterministic consensus if at least one general is a traitor (randomized consensus algorithms can circumvent the FLP impossibility theorem).

- Is there hope? Yes: we can have mechanisms that “nearly always” work.

- The blockchain, prosed by Satoshi Nakamoto in 2008 building on Haber and Stornetta (1991) and Bayer, Haber, and Stornetta (1992), is one of them.

- Distributed ledger with consensus and proofs-of-work.

- Advantages and disadvantages.
Central bank digital currency
A central bank open to all?

- The arrival of private cryptocurrencies has suggested the possibility that central banks issue their own digital currencies (CBDCs).
- Many proponents of a CBDC go well beyond a basic central bank-issued electronic money.

Barrdear and Kumhof, 2016, p.7

By CBDC, we refer to a central bank granting universal, electronic, 24x7, national-currency-denominated and interest-bearing access to its balance sheet.

Bordo and Levin, 2017

“an account-based CBDC could be implemented via accounts held directly at the central bank” [p. 7] or “CBDC could be provided to the public via specially designated accounts at supervised commercial banks, which would hold the corresponding amount of funds in segregated reserve accounts at the central bank” [p. 8].
Our question
Should central banks open their deposit and lending facilities to all firms and private citizens?

- This question is separate from assessing the merits of electronic public money, but it is really the one at the core of our discussion.

- Tobin (1987): “deposited currency” (and implemented in the past!).

- Related with the motivation behind postal saving systems and government-owned commercial banks.

- Why now? Changes in technology may justify changes in the architecture of a financial system.

- Nearly all of the analysis carries over to this “deposited currency” environment.

- Already relevant for policy: 2018 Swiss sovereign-money initiative (Vollgeld)
How can I address this question?

- I will briefly review the historical experience.

- I will summarize the results coming from a version of the Diamond and Dybvig (1983) model augmented with a central bank that allows for deposits by consumers.

  1. Basic equivalence result: central banks can deliver the right amount of maturity transformation.

  2. Conditions on commercial and central bank runs.

- I also have a nominal economy in a companion paper, but I will skip it today.
All of this has happened before...

- Historically, many central banks allowed deposits by and extended loans to firms and private citizens.


- The Bank War between Andrew Jackson and Nicholas Biddle was linked directly to the operations of the Second Bank of the United States with firms and merchants.

- Sometimes, the central banks were dominant players in the commercial banking sector.

- In 1900, the Bank of Spain (Banco de España), with 58 branches across the nation, held 68% of total financial assets and 75% of all checking accounts in the Spanish financial sector.

- Sharp distinction between a central bank operating only with primary depository institutions and commercial banks dealing with the public at large is mainly a post-WWII development.
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George Frederick Handell

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Samuel Handley of Nuyrk Shores
By 1900 they had multiplied sixfold. Lastly, the Bank consolidated its privileged relationship with the Treasury. The financial agreement of 1868 whereby the Bank assumed the responsibility for collecting taxes in return for making monthly advances to the Treasury remained in place for the following 20 years, and was then renewed for a further five years. Thereafter, the renewal was discussed yearly. The Bank was also responsible for servicing public debt, including making interest payments and repayments of principal.

Figures 5.1 and 5.2 provide a cursory overview of the growth of the Bank's balance sheet. Total assets multiplied by a factor of ten between 1874 and the turn of the century. Growth then halted for a few years, for reasons to be explained later, before increasing again to reach a total of nearly 3 billion pesetas. The volume of banknotes also rose rapidly: from 71 million pesetas in 1874 to 1.6 billion by 1900 and more than 1.97 billion before the Great War.

The main factor behind the increase in the Bank's total assets was the public portfolio, government debt purchases and loans and advances to the Treasury which was in permanent need of resources to cover the yearly budget deficits. This is particularly clear in the period after 1895 when a huge amount of funds was required, first to combat the colonial rebellion in Cuba and later, in 1898, to wage the war against the United States on both the Caribbean and Pacific seaboards. When the conflicts ended, the Treasury

SOURCE: Banco de España, Memorias anuales.
Replication of the Optimal Contract
The central bank replicates the socially optimal commercial bank contract.

Optimal Maturity Supply
In equilibrium, the socially optimal contract is offered either by the commercial banks or the central bank or both. If both the central bank and the commercial bank have customers, then both banks are offering the optimal contract.
The proposition may seem obvious, but it captures an important point.

One may be worried that offering deposit contracts with central banks will impair the maturity transformation function of the commercial banking sector, resulting in fewer investments in long-term projects.

The proposition above shows that this will not be so if the central bank mimics the investment strategy of a commercial bank per relying on the investment bank sector.

If the deposits in the central bank do not have any additional advantage, the competitive pressures of commercial banks will force to adopt the “right” investment strategy.
But, if the central bank enjoys an additional advantage over the commercial banks (e.g., fiscal backing), we should not expect the efficient amount of maturity transformation.

Political-economic challenges.

The cleanest way out appears to be letting the central bank abstain from offering deposit contracts.
Conclusions
Monetary economics at the dawn of change

- We are at the start of a time of fast changes in how we implement transactions and record information in society.

- So far, much of the work involved with cryptocurrencies, the blockchain, and related technologies has been done by software developers and engineers.

- Monetary economics has much to say about these changes. We can bring to the table 300 years of monetary analysis.

- For instance, cryptocurrencies are, in my assessment and contrary to Hayek’s conjecture, worse than a well-run government fiat money, but they can be better than a poorly-run government money.

- We might have much better monetary systems in 25 years.