Ignorance, debt and cryptocurrencies:
The old and the new in the law and economics of concurrent currencies†

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Abstract
Cryptocurrencies can potentially unleash a sea change in banking, finance, and monetary systems. Given that issuing (central bank) money constitutes one of the prerogatives of modern states, it was expected that governments would actively engage in regulating cryptocurrencies. However, as of this writing, due to the uncertainty as to the possible future trajectories of evolving cryptocurrency ecosystems, governments have taken a relatively hands-off and wait-and-see approach to regulating such currencies. This approach may be justified within the theoretical information-economics framework of this paper, which compares the information economics of money and quasi-money creation within the current central banking, commercial banking and shadow banking systems with that of money creation within the cryptocurrency ecosystem. Although this paper focuses on bitcoin (BTC), its main points would equally apply to other decentralized cryptoassets that share similar properties with bitcoin.

The main contribution of this paper lies in the synthesis of information economics in finance - as related to the mechanisms of money and quasi-money creation in the banking and shadow banking sectors - and the mechanism of money creation in cryptocurrency ecosystem. In particular, drawing lessons from the literature on ‘safe assets’ and building on Holmstrom's seminal work (2015),1 this paper highlights striking differences in the basic information economics of cryptocurrencies as opposed to that of fiat currencies (including the monetary aggregates). The main finding of this paper is that, bitcoin trumps central bank money and private and quasi-private money - created by the banking and shadow banking systems – on

† The title of this paper is inspired by an article by Dang, Gorton and Holmström. See: Tri Vi Dang, Gary Gorton and Bengt Holmström, Ignorance, debt and financial crises' (2012) Yale University and Massachusetts Institute of Technology, working paper
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1 Bengt Holmstrom, "Understanding the Role of Debt in the Financial System," BIS Working Paper No 479 (2015).
account of its informational foundations. The superior information economics of bitcoin, which is built on symmetric (common) knowledge as to the inner workings of the Bitcoin Blockchain, as opposed to that of fiat currencies, which is built on symmetric ignorance as to the underlying collateral, would transform bitcoin into a new ‘safe’ asset holding the promise of maturing into a viable store of value, a potential medium of exchange, and possibly a unit of account. By comparing the information economics of central, commercial and shadow bank money with that of bitcoin, we highlight important aspects of information economics of bitcoin that would inform any future regulatory intervention in the cryptocurrency ecosystem.

**Keywords:** Cryptocurrency, Bitcoin, Blockchain, Information asymmetry, Safe asset, Money, Debt

**JEL classification:** E42, E51, E58, G01, G23, G28, K22, K23, K24
Introduction

Decentralized, permissionless and blockchain-based cryptocurrencies\(^2\) and their underlying technology are said to have as transformative an impact on value as the invention of the internet had on information.\(^3\) The Bitcoin Blockchain or its so-called distributed ‘trust machine’\(^4\) has eventually solved the age-old double-spending problem, which for decades hampered the advent of digital money for the internet. Prior to bitcoin (BTC), even outside the virtual space, addressing double-spending problem was delegated to trusted third parties with centralized ledgers, who used to verify and confirm financial transactions. Bitcoin solved this problem in a highly secure, decentralized, consensus-based and censorship-resistant manner, without relying on third parties. The proof of work (PoW)\(^5\) used in the Bitcoin Blockchain, despite being energy intensive, is a highly secure mechanism which provides a decentralized and incentive-compatible mechanism for verifying and confirming transactions, as well as securing the Bitcoin Blockchain itself.\(^6\)

Although solving the double-spending problem has been a significant step forward in introducing bitcoin as a medium of exchange, the more challenging problem proved to be its universal acceptance. As Minsky puts: “everyone can create money; the problem is to get it accepted”.\(^7\) As of this writing, the problem of price volatility has been a barrier discouraging universal adoption and has prevented bitcoin from becoming a unit of account\(^8\) and possibly a viable store of value.

Despite scepticism about the economic functions of bitcoin as money or currency,\(^9\) and its earlier tarnished image as a useful currency for criminals (e.g., the role of bitcoin as a means of payment in Ross Ulbricht’s

\(^2\) The origins of the idea of creating bitcoin-like currencies can be traced back to an article by David Chaum entitled “Security without Identification: Transaction Systems to make Big Brother Obsolete.”, but the idea culminated in the Nakamoto’s “Bitcoin: A Peer-to-Peer Electronic Cash System”.

See: David Chaum, 'Security without identification: Transaction systems to make big brother obsolete' (1985) 28 Communications of the ACM 1030

See also: Satoshi Nakamoto, Bitcoin: A peer-to-peer electronic cash system (2008)

\(^3\) For potential applications of blockchain technology in general, see: UK Government Office for Science, Distributed Ledger Technology: beyond block chain, 2016)

See also: Don Tapscott and Alex Tapscott, Blockchain Revolution: How the technology behind Bitcoin is changing money, business, and the world (Penguin Random House LLC 2016)

\(^4\) The Economist, The promise of the blockchain: The trust machine’ (2015);

\(^5\) The price volatility of bitcoin, as part of a premature asset class, should not come as a surprise. Perhaps the most difficult case to be made for bitcoin as a currency is the unit-of-account aspect of moneyness. As a commodity with a fixed supply schedule, the bitcoin would remain volatile for the foreseeable future in response to the demand shocks. Nonetheless, as will be shown in this paper, bitcoin price volatility has had a decreasing trend.

\(^6\) The proof of work in principles discourages 51% attack on the network, because to hack the network, the hacker should accumulate substantial amounts of the coins. Having accumulated the coins and invested in the mining infrastructure, the hacker would not have the economic incentive to hack the system anymore. See: Josh Stark, Making Sense of Cryptoeconomics (August 19, 2017)

See also: Katherine Heires, The Risks and Rewards of Blockchain Technology (March 1, 2016)

\(^7\) Hyman P. Minsky, Stabilizing an unstable economy (McGraw-Hill 1986) 255

\(^8\) For the unit-of-account purposes, the authors do not believe that the current decimal numbers can be a real bottleneck for bitcoin as it can be solved redefining the default standard for measuring bitcoin. Currently, there is one promising Bitcoin Improvement Proposal (BIP) for bits submitted by Jimmy Song in December 2017. It is a proposal to record BTC in ‘bits’, every bit having a corresponding value of one thousandth of a bitcoin (i.e., 1 bit = 100 satoshis). This proposal is known as Bits Denomination BIP. See: Jimmy Song, Bits Denomination BIP (GitHub, December 12, 2017) <https://github.com/bitcoin/bips/blob/master/bip-0176.medialiwiki> accessed February 09, 2018

\(^9\) David Yermack, ‘Is Bitcoin a real currency? An economic appraisal’ (2013) Working paper no. 19747 National Bureau of Economic Research For the legal nature and treatment of virtual currencies, see: Noah Vardi, ‘Bit by Bit: Assessing the Legal
Silk Road\textsuperscript{10}, and AlphaBay),\textsuperscript{11} security threats involving bitcoin exchanges, (e.g., the hack and subsequent failure of Mt. Gox),\textsuperscript{12} and vulnerabilities in some of the blockchain-based organizations (the hack of DAO),\textsuperscript{13} as of this writing, the Bitcoin Blockchain has proved its superior security, resilience and long-term viability.\textsuperscript{14} If cryptocurrencies, satisfy the critical mass constraint,\textsuperscript{15} some of them, in particular bitcoin, could potentially have a significant impact on the financial and monetary systems.\textsuperscript{16}

In this paper, after providing an introduction to the nature of cryptocurrencies, we will analyse whether bitcoin meets the classical definition of a currency. Thereafter, we will focus on the concept of money and building upon the literature on information-economics of debt contracts and safe assets, we will argue that bitcoin ticks virtually all the boxes of moneyness. Although bitcoin is similar to base money or central bank high-powered money\textsuperscript{17} and as such cannot be directly compared to the commercial bank money (i.e., bank-issued IOUs) or shadow bank money, the discussion of money creation in banking and shadow banking is necessary as it is helpful for understanding the creation of information-insensitivity in the process of (private or public-private) money creation. Our main contribution lies in the application of the information economics (especially in the context of safe assets and money and quasi-money creation within the shadow banking sector) to the cryptocurrency context and in highlighting the advantages and disadvantages of such currencies over the traditional fiat money. In particular, drawing lessons from the literature on ‘safe assets’ and building on Holmstrom's seminal work (2015),\textsuperscript{18} this paper highlights striking differences in the basic information economics of cryptocurrencies as opposed to that of fiat currencies (including the monetary aggregates).

\textsuperscript{10} Andy Greenberg, \textit{Silk Road Mastermind Ross Ulbricht Convicted of All 7 Charges} (April 02, 2015)
\textsuperscript{11} When Europol shut down AlphaBay, it seized large quantities of bitcoin, Zcash, Ether and some Monero. See: Europol, \textit{Massive blow to criminal dark web activities after globally coordinated operation} (20 July 2017)
\textsuperscript{12} See Lawrence Trautman, 'Virtual Currencies: Bitcoin & What Now after Liberty Reserve, Silk Road, and Mt. Gox' (2013) 20 Richmond Journal of Law & Technology 1
\textsuperscript{13} Securities and Exchange Commission, \textit{Report of Investigation Pursuant to Section 21(a) of the Securities Exchange Act of 1934: The DAO}, July 25, 2017
\textsuperscript{14} As of this writing, as listed on the coinmarketcap.com there are 1564 cryptocurrencies. The market cap of all cryptocurrencies on this website stands at $275,986,942,828 with BTC Dominance of 42.7%. (Accessed: 12.04.2018). See: Bitcoin obituaries: https://99bitcoins.com/bitcoinobituaries/
\textsuperscript{15} Ernie G.S. Teo, Emergence, Growth, and Sustainability of Bitcoin: The Network Economics Perspective’ in David Lee Kuo Chuen (ed), \textit{Handbook of Digital Currency: Bitcoin, Innovation, Financial Instruments, and Big Data} (Academic Press 2015)
\textsuperscript{16} See for example, Jeffrey Tucker, \textit{Op Ed: Is There a Future for Banking in a Cryptocurrency-Dominated World?} (Oct. 11, 2017)
\textsuperscript{17} Base money or high-powered money is the money issued by central banks and in most economies consists of coins and (central bank) notes.
\textsuperscript{18} Bengt Holmstrom, 'Understanding the role of debt in the financial system' (2015) BIS Working Paper No 479
Is bitcoin a currency? A crisis of identity

“Men of business in England do not...like the currency question. They are perplexed to define accurately what money is: how to count they know, but what to count they do not know.”

On August 21, 2017, a proposal was laid out by the Managing Director at e-Residency of Estonia for issuing crypto tokens - called ‘estcoins’ - to its e-residents through an Initial Coin Offering (ICO). The idea could be further extended to build a sovereign wealth fund on top of such a currency. On September 07, 2017, however, the European Central Bank’s (ECB) Mario Draghi rejected Estonia’s idea of issuing virtual currencies stating that “… no member state can introduce its own currency… The currency of the euro zone is the euro.” Developments of this kind, along with the keen interest of central bankers in studying and potentially issuing their own cryptocurrencies, have shown that cryptocurrencies have the potential to compete with fiat currency, especially the central bank money.

Although there is no single agreed-upon definition of a currency or money, a classic textbook definition of a currency comprises anything exhibiting three key features of being a medium of exchange, a unit of account and a store of value. Based on the above definition, bitcoin, as of this writing, cannot be considered as a currency. However, monetary economists (including historians of monetary economics) may disagree with the classic textbook definition on the notion and evolution of money. In general, there

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19 Walter Bagehot, 'The General Aspect of the Banking Question' in Norman St John Stevas (ed), The Collected Works of Walter Bagehot, vol 9 (The Economist 1857)
20 Kaspar Korjus, Estonia could offer ‘estcoins’ to e-residents: The proposal to issue crypto tokens would make the Republic of Estonia the first country with an Initial Coin Offering (ICO) (2017)
21 Lionel Laurent, The Bitcoin Sovereign Wealth Fund; Estonia wants in on the crypto-currency bubble' Bloomberg (https://www.bloomberg.com/gadfly/articles/2017-08-25/forget-oil-future-sovereign-wealth-funds-run-on-bitcoin?cmpid=socialflow-business&utm_content=business&utm_campaign=socialflow-organic&utm_source=twitter&utm_medium=social>
22 Reuters Staff, 'ECB's Draghi rejects Estonia’s virtual currency idea' Reuters (<https://www.reuters.com/article/us-ecb-bitcoin-estonia/ecbs-draghi-rejects-estonias-virtual-currency-idea-idUSKCN1BI2BI>)
23 Morten Bech and Rodney Grrarratt, 'Central Bank Cryptocurrencies' (2017) BIS Quarterly Review. Other central banks, such as Sweden’s Riksbank, are considering issuing digital currencies (e-krona in the case of Riksbank), though as of this writing, there is no final decision as to the issue or technical specification of e-krona. To follow this project, see: https://www.riksbank.se/en-gb/financial-stability/the-financial-system/payments/does-sweden-need-an-e-krona/. For the pros and cons of central bank digital currencies, see; Max Raskin and David Yermack, Digital Currencies, Decentralized Ledgers, and the Future of Central Banking, (2016)
24 Milton Friedman, 'The Island of Stone Money' (1991) The Hoover Institution Working Papers in Economics E-91-3 ; See also: Michael F. Bryan, 'Island Money' (2004) Federal Reserve Bank of Cleveland, Economic Commentary There are apparently some differences between money and currency according to some scholars. For examples and detailed discussion of different meanings of money in a legal context, see: Charles Proctor, Mann on the Legal aspect of money (7 edn, Oxford University Press 2012), Chapter 1.
25 Charles Proctor, Mann on the Legal aspect of money Chapter 1. Proctor/Mann add(s) “a measure of value” or “a standard for contractual obligations” in the functional definition of money, however, he also views the medium of exchange function as the key feature of money. See also: Jack Weatherford, The history of money: From Sandstone to Cyberspace (Crown Publishers, Inc. 1997) 20; David Graeber, Debt: the first 5,000 years (Melville House Publishing 2011) (Viewing money as a unit of account for debt.)
26 David Yermack, 'Is bitcoin a real currency? An economic appraisal' (2013) NBER Working Paper Series 19747
are two prevailing schools of thought on money. On the one hand, the credit theory of money advocates a
credit or debt-based monetary system, by mainly emphasizing the role of money as a unit of account, or
a ledger on which assets and liabilities are recorded. On the other hand, the commodity theory of money
argues for a commodity-based monetary system by mainly focusing on the role of money as a medium of
exchange or a store of value.

As regards the role of state in monetary systems, two prevailing schools of thought exist. One school, which
can be viewed as state theory of money, championed by Georg Knapp and Abbe Lerner, views government
power to tax, together with legal tender status, as central to moneyness. The second school of thought can
basically be described as the spontaneous or emergent theory of money, which goes back to the works of
Carl Menger on the origins of money. Some proponents of this school view universal acceptance as a
medium of exchange as a single criterion of moneyness. Historical evidence for the claim that anything
that is generally accepted as a medium of exchange can be considered as money abounds. For instance,
Weatherford reports that while cocoa beans were used as a medium of exchange (money) in Mesoamerica,
when a ship load of them belonging to Mesoamericans was seized by European pirates, the pirates dumped
the entire cargo of cacao beans into the sea, (mis)taking the beans for rabbit dung.

It seems that bitcoin and cryptocurrencies in general, can best fit the definition of money adopted by the
spontaneous theory of money. Friedrich Hayek, George Selgin, Richard Timberlake, Roland Vaubel,
Lawrence White, and Leland Yeager are the most vocal theorists of this approach who believe in free
banking and the proposition that in a ‘concurrent’ currency setting, good money would drive bad money
out of circulation.

Although the lack of intrinsic value has been considered as a roadblock in the way of bitcoin to become
money, history of money suggests that to become money, intrinsic value could be irrelevant and any object
could become money or quasi-money upon acceptance by the general public. Depending on the various

27 A Mitchell Innes, ‘The credit theory of money’ in L. Randall Wray (ed), Credit and State Theories of Money: The Contributions of A Mitchell Innes (Edward Elgar Publishing Limited 2004) David Graeber (an anthropologist who provides significant evidence that money has emerged as a unit of account for debt. See Graeber, Debt: the first 5,000 years
28 Georg Friedrich Knapp, ‘The state theory of money’ (1924) History of Economic Thought Books ; see also; Abba P. Lerner, ‘Money as a Creature of the State’ (1947) 37 The American Economic Review 312
29 Some texts refer to this theory as ‘Societary Theory of Money’. See: Proctor, Mann on the Legal aspect of money
30 Karl Menger, ‘On the Origin of Money’ (1892) 2 The Economic Journal 239; See also: Mikael Stenkula, ‘Carl Menger and the network theory of money’ (2003) 10 The European Journal of the History of Economic Thought 587
31 Lawrence H. White, Competition and currency: Essays on free banking and money (New York University Press 1989) 7
32 Perhaps the best illustration of the spontaneous theory of money can be found in Radford’s work in which he illustrates how cigarettes became the standard of value and currency in the Prisoner of War Camp. See: R. A. Radford, ‘The Economic Organisation of a P.O.W. Camp’ (1945) 12 Economica 189
33 Weatherford, The history of money: From Sandstone to Cyberspace
34 Friedrich A Von Hayek, Choice in currency: a way to stop inflation (The Institute of Economic Affairs 1976); George Selgin, ‘Salvaging Gresham's Law: The Good, the Bad, and the Illegal’ (1996) 28 Journal of Money, Credit and Banking 637
35 Although one could argue that the intrinsic value of bitcoin is the security of bitcoin blockchain to which bitcoin is encoded.
36 Friedman, ‘The Island of Stone Money’; Bryan, ‘Island Money’; Radford, ‘The Economic Organisation of a P.O.W. Camp’
definitions of money, some cryptocurrencies can meet the criteria of moneyness and some cannot. For example, if the benchmark is the universal acceptance (based mainly on the spontaneous or emergent theory of money) criterion, bitcoin, as the prime example of a cryptocurrency, could possibly meet the definition of currency.\textsuperscript{37}

However, according to the rival schools of thought, at its current form, bitcoin may not meet the criteria of moneyness, because it is mainly held and used for speculation with an expectation that it will become a stable store of value, a medium of exchange, and a unit of account.\textsuperscript{38} Nonetheless, since bitcoin is an evolving phenomenon, it is highly likely that through time and with emergent upgrades to bitcoin protocol, such as scaling solutions, such as Segregated witness (Segwit), second-layer solutions such as Lightning Network,\textsuperscript{39} and proposals for redefining the default standard for measuring bitcoin, such as Bits denomination BIP,\textsuperscript{40} it would prove to become a fully-fledged (programmable) money under the spontaneous theory of money.

Alongside bitcoin, the cryptocurrency ecosystem includes a whole variety of other cryptoassets. Overall, assets created using cryptography could fall under the umbrella term of cryptoassets.\textsuperscript{41} However, cryptoassets suffer from a crisis of identity.\textsuperscript{42} This is mainly because they differ widely from one another,\textsuperscript{43} and many tokens or cryptocurrencies listed in cryptocurrency exchanges may not meet the required criteria of moneyness. On the contrary, upon a closer scrutiny, a majority of digital tokens issued through ICOs can easily meet the definition of an investment contract (security), such as the tokens issued by DAO.\textsuperscript{44}

Similar to the elephant-in-the-dark-room metaphor, regulators have also taken different stances on the nature of cryptocurrencies. Tax authorities have designated cryptocurrencies as property. Commodity markets authorities have viewed them as commodity.\textsuperscript{45} Securities regulators have seen them as security,\textsuperscript{46}

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\textsuperscript{37} As of this writing, the number of businesses and individuals accepting bitcoin as a medium of exchange is limited. For a map of bitcoin accepting venues, see: http://coingap.org/#/map/45.5499577/10.50400257/15

\textsuperscript{38} There are improvements on Bitcoin protocol and also second layer solutions that promise to make bitcoin good for all the above-mentioned purposes. For an overview of two such business improvements called “market exchange pricing”, and “instantaneous exchange facilities”, see: William Luther and Lawrence White, 'Can bitcoin become a major currency?' (2014) JMU Working Paper in Economics No 14-17. See also: Song, 'Bits Denomination BIP'

\textsuperscript{39} Joseph Poon and Thaddeus Dryja, 'The bitcoin lightning network: Scalable off-chain instant payments' (2016)

\textsuperscript{40} Song, 'Bits Denomination BIP'

\textsuperscript{41} Chris Burniske and Jack Tatar, Cryptoassets: The Innovative Investor's Guide to Bitcoin and Beyond (McGraw Hill 2018)

\textsuperscript{42} For regulatory implications of the crisis of identity, see: Hadar Yoana Jabotinsky, The Regulation of Cryptocurrencies - between a Currency and a Financial Product' (2018) SSRN

\textsuperscript{43} European Central Bank, 'Virtual currency schemes - a further analysis' (2015)

\textsuperscript{44} Commission, Report of Investigation Pursuant to Section 21(a) of the Securities Exchange Act of 1934: The DAO

\textsuperscript{45} Commodity Futures Trading Commission, In the Matter of: Coinflip, Inc., d/b/a Derivabit, and Francisco Riordan, Respondents: Order instituting proceedings pursuant to sections 6(c) and 6(d) of the commodity exchange act, making findings and imposing remedial sanctions (CFTC Docket No. 15-29) (September 17, 2015)

\textsuperscript{46} Commission, Report of Investigation Pursuant to Section 21(a) of the Securities Exchange Act of 1934: The DAO
and regulators in charge of money or financial crime have designated them as currency. In addition, regulators around the globe have attempted to define cryptocurrencies. In many legal and statutory texts, as well as central banking nomenclature, cryptocurrencies are often dubbed as virtual or digital currencies. For example, a virtual currency, is defined in the § 102(23) of the U.S. Uniform Regulation of Virtual-Currency Business Act (URVCBA) as a “(A) digital representation of value that: (1) is used as a medium of exchange, unit of account, or store of value; and (2) is not legal tender, whether or not denominated in legal tender”. The New York Bitlicense defines virtual currencies as “any type of digital unit that is used as a medium of exchange or a form of digitally stored value. Virtual Currency shall be broadly construed to include digital units of exchange that (i) have a centralized repository or administrator; (ii) are decentralized and have no centralized repository or administrator; or (iii) may be created or obtained by computing or manufacturing effort.” The ECB defines virtual currencies as “a digital representation of value, not issued by a central bank, credit institution or e-money institution, which in some circumstances can be used as an alternative to money”. In ECB’s view, virtual currencies are not money nor currency from a legal standpoint. It seems that these definitions have been intentionally broadly constructed to include the majority of the cryptocurrencies, even if they may not be a medium of exchange or a store of value.

From a legal perspective, cryptocurrencies should also be differentiated from electronic money (e-money). E-money is always at par with fiat money. The main difference between e-money and fiat money is that e-money is the digital representation of fiat money stored on an electronic chip. However, cryptocurrencies are self-anchored and are not pegged to any currency. In other words, they have a floating rate against major currencies. In addition, e-money issuers should redeem the monetary value of the e-money at par and on demand, whereas such an obligation does not exist for cryptocurrency developers or issuers.

47 § 102(23) of the Uniform Regulation of Virtual-Currency Business Act (URVCBA)
48 Section 200.2(p) Bitlicense, New York Department of Financial Services, New York Codes, Rules and Regulations; Title 23, Department of Financial Services, Chapter I. Regulations of the Superintendent of Financial Services, Part 200, Virtual Currencies.
49 Bank, ‘Virtual currency schemes- a further analysis’ ibid
50 Sarah Rotman, Bitcoin Versus Electronic Money (CGAP Brief, 23 January 2014)
51 E-money is always at par with fiat money. The main difference between e-money and fiat money is that e-money is the digital representation of fiat money stored on an electronic chip. However, cryptocurrencies are self-anchored and are not pegged to any currency. In other words, they have a floating rate against major currencies. In addition, e-money issuers should redeem the monetary value of the e-money at par and on demand, whereas such an obligation does not exist for cryptocurrency developers or issuers.

52 Article 2(2) for the E-money directive defines e-money as a monetary value represented as a claim on the issuer which is stored on an electronic device & accepted as a means of payment by undertakings other than the issuer. See Directive 2009/110/EC of the European Parliament and of the Council of 16 September 2009 on the taking up, pursuit and prudential supervision of the business of electronic money institutions amending Directives 2005/60/EC and 2006/48/EC and repealing Directive 2000/46/EC, OJ L 267, 10.10.2009, p. 7–17.
53 Though they can be pegged to fiat currencies (e.g., USD)
54 Art. 11 Directive 2009/110/EC of the European Parliament and of the Council of 16 September 2009 on the taking up, pursuit and prudential supervision of the business of electronic money institutions amending Directives 2005/60/EC and 2006/48/EC and repealing Directive 2000/46/EC, OJ L 267, 10.10.2009, p. 7–17.
The anonymous attribute in the customer identification section of the above table is not an accurate designation. As bitcoin transactions are not anonymous, but pseudonymous.

Four main properties of bitcoin set it apart from traditional central bank money: decentralization, consensus mechanism, potential for monetary sovereignty, and censorship resistance. Bitcoin has created an incentive-compatible ecosystem for the security and maintenance of the Bitcoin Blockchain leading to the creation of a decentralized money. In this view, the idea of central bank cryptocurrency (CBCC), put forward by, among others, Bech and Grarratt of the Bank for International Settlements (BIS),\(^5\) which keeps the issuance of money under the control of the central bank, but decentralizes the settlement method (peer-to-peer settlement) would seem as an oxymoron.\(^6\) This paper, also does not view such cryptocurrencies as true cryptocurrencies; they may best be classified as (centralized) digital money or cash with a peer-to-peer settlement mechanism.

For the purpose of classification, many of the so-called cryptocurrencies can best be described as cryptoassets that could further be classified as digital commodities (cryptocommodities) representing raw digital resources, or digital tokens (cryptotokens) representing finished digital goods and services.\(^7\) Some of these assets can potentially become a new asset class with potential of maturing into a valuable portfolio.

\(^3\) The European Commission Electronic Money Directive (2009/110/EC). http://ec.europa.eu/internal_market/payments/emoney/text/index_en.htm

\(^5\) Bech and Grarratt, 'Central Bank Cryptocurrencies' In their view a central bank cryptocurrency (CBCC) is “an electronic form of central bank money that can be exchanged in a decentralised manner known as peer-to-peer, meaning that transactions occur directly between the payer and the payee without the need for a central intermediary.” Bech and Grarratt, 'Central Bank Cryptocurrencies' In other words, in central bank cryptocurrency, the money creation leg of currency still remains to be the prerogative of governments (central banks) but the settlement leg is decentralized and organized in a peer-to-peer fashion.

\(^6\) For an engaging read on the CBCC, see: JP Koning, Fedcoin (October 19, 2014)

\(^7\) Burniske and Tatar, Cryptoassets: The Innovative Investor's Guide to Bitcoin and Beyond Chapter 4.
This paper focuses on bitcoin, which is the most well-known and the largest cryptocurrency in terms of market cap. Although bitcoin has been designated as a commodity, it has a hybrid nature, displaying the features of both commodities and currencies. Perhaps as of this writing, bitcoin might best be seen as a form of commodity money, or in Selgin’s words ‘synthetic commodity money’. Despite the focus on bitcoin, the analysis of this paper would apply, with varying degrees, to many other cryptocurrencies such as Litecoin (LTC), Dash (DASH), Ripple (XRP), Monero (XMR), and Zcash (ZEC), which exhibit features that are considerably closer to currencies or commodities than investment contracts (securities).

**Information economics: how bitcoin differs from fiat currency**

According to Perry Mehrling, under the gold standard, gold (the ultimate international means of payment), national currencies (promises to pay gold), bank deposits (promises to pay currency on demand), and securities (promises to pay currency or deposits during certain period of time in the future) used to constitute the hierarchy of money; with gold being at the apex of the hierarchy and securities at the bottom.

![A Simple Hierarchy](image)

Source: Mehrling, P. (2012). "The inherent hierarchy of money."

In the fiat money framework, the concept of hierarchy of money can be reconfigured based on the ‘safety’ or ‘information insensitivity’ of a financial instrument. In other words, another way to construct a concept of hierarchy in the fiat currency system is to build this concept based on the information economics of a

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58 Aleksander Berentsen and Fabian Schär, 'A Short Introduction to the World of Cryptocurrencies' (First Quarter 2018) 100 Federal Reserve Bank of St Louis Review 1
59 Selgin defines synthetic commodity money as “money that lacks nonmonetary value but is nevertheless reproducible only at a positive and rising marginal production cost, if indeed it can be reproduced at any cost at all.” George Selgin, ‘Synthetic commodity money’ (2015) 17 Journal of Financial Stability 92 95
60 Perry Mehrling, 'The inherent hierarchy of money' (2012) 169 Social Fairness and Economics: economic essays in the spirit of Duncan Foley 394
particular financial instrument or asset. The most information-insensitive (the safest) assets being at the top of the hierarchy of money, the least information-insensitive (the riskiest) assets lying at the bottom. Therefore, within this framework, the level of safety of an asset as a means of settlement would be the benchmark against which the concept of hierarchy is built; the source of safety being the money claims’ proximity to the government; i.e., the ultimate source of official liquidity and credit puts that make money claims information insensitive.

One essential difference between cryptocurrencies and fiat money (cash or banknotes and deposit money created by banks) is that fiat money is invariably the liability of someone, which has to be redeemed by the issuing entity. Likewise, the rest of the monetary aggregates (i.e., parts of the M1, M2, and M3) is the liability of someone (mainly governments and banks). But bitcoin, similar to a commodity money, is the liability of no one. To put it differently, from a legal standpoint, traditional currencies are debt contracts.

Although initially government-issued money had to be redeemed in gold or silver, with the rise of fiat money, the ‘full faith and credit’ of governments replaced the convertibility of the money to gold or silver. The power of state to (future) taxes, which itself depends upon the GDP growth is mainly what backs the fiat money. And the fact that fiat money would be accepted by the government for tax purposes ensured that such a currency would be good for the discharge of debt (and hence a store of value for future debt repayment), and ultimately promoted the universal adoption of the fiat money (medium of exchange).

Unlike the state theory of money, which presupposes that for something to become money, it needs to be recognized by the state as money, in this section, we argue that for something to become a store of value, a medium of exchange, or a unit of account, it only needs to possess certain safety features. In other words,

61 It is not readily conceivable to see if the central bank money is a liability, one interpretation would be that central bank money is a liability in the sense that the central bank commits to certain inflation targets (price stability; say 2% annual inflation). Such a commitment would mean that the central bank promises to pay the holder of the note/coin a certain amount of the number of goods included in the basket of goods that comprises the Consumer Price Index (CPI). Therefore, the holder of the note can redeem the central bank money in terms of the commodities included in the CPI. See: Nick Rowe, From gold standard to CPI standard (2015); Nick Rowe, Is money a liability? (2012) However, such a promise would not be considered as a binding legal contract as the central bank enjoys theoretically unlimited discretion on inflating the currency. Some theories, such as the credit theory of money, suggest that there is no need for redeemability. For example, Mitchell Innes casts significant doubt on whether redeemability has been a feature of currency even under the metallic standard. See: A Mitchell Innes, ‘What is money?’ in L. Randall Wray (ed), Credit and State Theories of Money: The Contributions of A Mitchell Innes (Edward Elgar Publishing Limited 2004) 36

62 According to the ECB’s definition monetary aggregates “comprise monetary liabilities of MFI’s [monetary financial institutions] and central government (post office, treasury, etc.) vis-à-vis non-MFI euro area residents excluding central government.

- M1 is the sum of currency in circulation and overnight deposits;
- M2 is the sum of M1, deposits with an agreed maturity of up to two years and deposits redeemable at notice of up to three months; and
- M3 is the sum of M2, repurchase agreements, money market fund shares/units and debt securities with a maturity of up to two years.” See: ECB, Monetary aggregates, available at: https://www.ecb.europa.eu/stats/money_credit_banking/monetary_aggregates/html/index.en.html

63 Proctor, Mann on the Legal aspect of money Chapter 1. See also Graeber, Debt: the first 5,000 years

64 Though there is disagreement on this point between the proponents of the credit theory of money and those supporting commodity money.
for something to become a currency, it needs to first be, or perceived to be, a ‘safe asset’. The safe-asset property of a currency can pave the way for its universal adoption. We will explain then how safety enhancing features of assets (money and quasi-money) in financial and monetary systems have been at work for decades and will show how bitcoin’s safety features differ from traditional currencies. We will also argue that in terms of information economics the safety features of bitcoin are superior to that of fiat money by framing an informational dichotomy, i.e., symmetric ignorance vs. symmetric (common) knowledge.

In fiat currency context, A is willing to accept a piece of paper as a method of payment (legal tender)\(^{65}\) in anticipation of B willing to accept it from A, and C willing to accept it from A and B, ad infinitum. For this to happen, the settlement asset should not give rise to any adverse selection problem arising from the information asymmetry as to the value of the settlement asset. In other words, the asset should be perceived as ‘safe’ and its safety should be common knowledge. By definition, a safe asset is an information-insensitive asset,\(^{66}\) holding the promise of becoming a high-quality store of value, a medium of exchange and potentially a unit of account. In other words, in order for a financial instrument to become a store of value and a medium of exchange, it should be highly information-insensitive.\(^{67}\)

Finance literature suggests that debt instruments have traditionally been superior to equity instruments in addressing informational problems between borrowers (issuers) and lenders (shareholders).\(^{68}\) Debt

\(^{65}\) “Legal tender is such money in the legal sense as the legislator has so defined in the statutes which organize the monetary system. Chattels which are legal tender therefore necessarily have the quality of money but the converse is not true—not all money is necessarily legal tender.” See Proctor, *Mann on the Legal aspect of money*, Chapter 2. See also “Vick v Howard 136 Va 101, 109,” and “Emperor of Austria v Day (1861) 3 DeG F & J 217, 234; stating that foreign notes and coins “might pass as money without being legal tender”.

\(^{66}\) Gary Gorton, Stefan Lewellen and Andrew Metrick, ‘The Safe-Asset Share’ (2012) 102 The American Economic Review 101 102

\(^{67}\) The analogy to bitcoin could be made as to the underlying design of the Bitcoin Blockchain. Unlike fiat money, bitcoin as a commodity money, is self-anchored and its value is not pegged to any other commodity or contract. However, the trust in bitcoin, especially as a store of value, comes from the fact that it is based on the embedded rules or algorithms governing the Bitcoin Blockchain, that it is decentralized and that its monetary policy should be decided by a specific consensus mechanism. In addition, artificial scarcity in this ‘digital’ currency plays an important role in the moneyness of bitcoin. Therefore, the value of bitcoin largely originates from holding a digital unit of a means of a store of value, medium of exchange and unit of account on the Bitcoin Blockchain as a secure, decentralized (and intermediary-free), censorship-resistant network for digital payments and settlements. In this sense, the value of bitcoin deriving from the trust in the Bitcoin Blockchain would very much resemble the arguments put forward by the institutional theory of money which states that money is “no more than credit against an obligor, whose acceptance as a store of value and as a means of payment by the public is dependent on a comprehensive legal framework that ensures stable purchasing power, its availability even in time of banking stress and its functional capability to settle monetary obligations. It is no longer a chattel, but a transferable credit within an overall institutional framework.” See: Antonio Sáinz de Vicuña, ‘An Institutional Theory of Money’ in Mario Giovanoli and Diego Devos (eds), *International Monetary and Financial Law: The Global Crisis* (Oxford University Press 2010) 517 (paragraph 25.01)

Some commentators view bitcoin’s self-anchored property as its principal weakness as it causes inherent instability in its value. See: Geva, ‘Disintermediating Electronic Payments: Digital Cash and Virtual Currencies’

\(^{68}\) These informational advantages originate from the fact that at the contracting stage, debt instruments are an optimal instrument to address private information. See: David C. Nachman and Thomas H. Noe, ‘Optimal Design of Securities Under Asymmetric Information’ (1994) 7 The Review of Financial Studies 1. At this stage, if lenders screen borrowers, debt instruments can optimize information collection. See: Roman Inderst and Holger M. Mueller, ‘Informed Lending and Security Design’ (2006) 61 The Journal of Finance 2137 In addition, debt instruments are better positioned to address the moral hazard behavior of managers. Robert D.
instruments not only economize on the cost of information collection at the contract execution stage, but also on the liquidation cost of collateral. Debt-on-debt (debt used as collateral for another debt contract) minimizes financial market participants’ incentives to produce private information about the ultimate payoffs. This makes debt the least information-sensitive instrument in the financial markets. In other words, “the argument for the optimality of debt is simply that it’s easiest to trade if you’re sure that neither party knows anything about the payoff on the debt.” This near-information insensitivity removes adverse selection problem, contributes to liquidity of debt instruments, helps universal adoption and thereby makes them a viable instrument for both market and funding liquidity.

The informational advantage of debt instruments, i.e., information insensitivity, makes them a relatively better instrument to be used for issuing money claims. This is because an information-insensitive financial instrument would be highly liquid and adverse-selection proof. Liquidity of information-insensitive instruments and adverse-selection-proof property of such instruments would make them suitable for use as a medium of exchange. For example, aside from central bank money (which is currently the most information insensitive financial instrument), bank claims can effectively become money as the prudential regulation together with government credit and liquidity puts (deposit insurance and lender of last resort (LOLR), respectively) make them information insensitive and a viable choice for a medium of exchange and a store of value, making such claims even suitable as an ultimate settlement asset used in the operations by the financial market infrastructures. In the absence of such government measures and

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Innes, 'Limited liability and incentive contracting with ex-ante action choices' (1990) 52 Journal of Economic Theory 45
Debt is also the least information-sensitive instruments to ex-post public information. See: Peter M. DeMarzo, Ilan Kremer and Andrzej Skrzypacz, 'Bidding with Securities: Auctions and Security Design' (2005) 95 American Economic Review 936
Robert M. Townsend, 'Optimal contracts and competitive markets with costly state verification' (1979) 21 Journal of Economic Theory 265; See also: Oliver Hart and John Moore, 'Default and Renegotiation: A Dynamic Model of Debt' (1998) 113 The Quarterly Journal of Economics

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Gary Gorton, *Shadow Banking* (Federal Reserve Bank of Minneapolis December 2010) 19

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This difference in economics of information in the equity markets versus debt markets projects itself in the organization and structure of these two markets. Stocks markets are organized to facilitate price discovery, money markets are organized to enhance liquidity. And to do so, they must obviate the need for price discovery. See: Holmstrom, 'Understanding the role of debt in the financial system'

For the difference between funding and market liquidity, see: Markus K. Brunnermeier and Lasse Heje Pedersen, 'Market Liquidity and Funding Liquidity' (2009) 22 The Review of Financial Studies 2201

Dang, Gorton and Holmström, 'Ignorance, debt and financial crises' For bitcoin and other cryptocurrencies to become money, they need to become information insensitive. As soon as a currency becomes information sensitive, it would lose its moneyness.

The core banking claims (deposits) also enjoy government (limited) credit and liquidity puts. In other words, the trust in banking claims - used as money - comes from the trust in the government backing such claims (trust in the prudential regulation and liquidity and credit puts).

This is perhaps why bank are considered traditionally opaque. Indeed, the logic behind transparency in equity markets does not apply to money markets. See: Holmstrom, 'Understanding the role of debt in the financial system'

Before the advent of central banking, clearing houses, by undertaking functions similar to central banks, could ensure that checks would trade at par by adding a layer of endogenous opacity. See Gary Gorton, 'The development of opacity in U.S. banking' (2013) 31 Yale Journal on Regulation 825 839; See also Gary B. Gorton, *Slapped by the Invisible Hand: The Panic of 2007* (Oxford University Press 2010)
protections, bank claims would not have been redeemable at par on demand, and would have long ceased to be money.\footnote{77 Gorton, ‘The development of opacity in U.S. banking’}

For something to become a medium of exchange, the first and utmost important factor is the safety feature. In transactional terms, the less an asset is prone to adverse selection, the better it is for transactional purposes (medium of exchange). There are different ways of mitigating adverse selection. Since adverse selection exists because of information asymmetry, signalling and screening have traditionally been two main mechanisms to mitigate information asymmetry.\footnote{78 See for example: George A. Akerlof, ‘The Market for “Lemons”: Quality Uncertainty and the Market Mechanism’ (1970) 84 The Quarterly Journal of Economics 488} Another major way of addressing adverse selection problem is to basically do away with information asymmetry by either shedding sunlight on the settlement asset so that its value would be symmetrically and perfectly evaluated by both parties onto a transaction (common knowledge), or by obscuring and hiding all the information so that neither parties to a transaction could be able or would have incentive to acquire information (symmetric ignorance). Since an ultimate means of settlement needs to be the most information insensitive and completely free from adverse selection problem, we argue that for such an asset (money), neither signalling nor screening mechanisms would provide complete information insensitivity. Instead, for such an asset to best perform its function as an ultimate means of settlement, its value and underlying mechanisms should be either common knowledge or should not be known to any financial market participant at all (symmetric ignorance). In money markets, laddered safety is no safety.

The safety feature of an asset can be enhanced either through public/government guarantees or through private mechanisms.\footnote{79 There would be other safety enhancing mechanism such as pegging the price of a currency to the price of a basket of commodities.} Since bitcoin is a decentralized asset, this paper does not suggest increasing the safety of bitcoin as a store of value by relying on government credit or liquidity puts (if ever possible!) as that suggestion would defeat the very purpose of bitcoin in the first place. And since bitcoin is the first digital asset, pegging its price to a basket of physical commodities would be counterproductive and would defeat the purpose for which it is created.\footnote{80 There are such proposals to tie or peg bitcoin’s price to certain commodities. See for example: Gideon Samid, Tethered money: managing digital currency transactions (Academic Press 2015) 16 & 114} In what comes next, we draw analogies between safety-enhancing mechanisms in the current (shadow) banking system\footnote{81 For a discussion of shadow banking definition and its regulation see: Hossein Nabilou and Alessio Pacces, ‘The Law and Economics of Shadow Banking’ in Iris H. Chiu (ed), Research Handbook in Shadow Banking (forthcoming 2017)} and in the end, compare them to the design of the Bitcoin Blockchain.
How banks and shadow banks create money?

Historically banks and shadow banks have been in the money creation business. Bills of exchange were used to be a remedy for the scarcity of money and soon became the money for merchants. According to some commentators, shadow banking has existed at least since the late 19th century, when the Bank of England initiated a program to stabilize the private bills markets by bailing out bill brokers. These brokers were not banks. However, they were accepting to convert the bills into money, an activity that would be called shadow banking today. Therefore, contrary to the public perception, money is far more elusive a concept than what initially appears to be, and many entities alongside the central bank can create it.

In one classification, Pozsar (2014), arguing for the introduction of a new set of monetary aggregates that is able to track the supply of money and money-like claims for financial economy transactions (rather than real-economy transactions), defines money as something that trades at par on demand. He further classifies currency, reserves and T-bills as purely public money (public money), insured bank deposits as private-public money (insured money), government repos and Constant Net Asset Value (CNAV) share of government-only Money Market Funds (MMFs) as public-private money (public shadow money), and repos collateralized by credit-risky private securities, CNAV shares of prime funds, and uninsured deposits as purely private money (private shadow money). The latter instruments lack even an indirect access to public liquidity and credit puts. In this view, four main institutions create money: central banks, banks, dealer banks and money market funds. A common denominator in all of the above classifications is the quest for safety (information-insensitivity) engineered using private mechanisms in the absence of public credit and liquidity puts.

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82 Perry Mehrling and others, ‘Bagehot was a shadow banker: shadow banking, central banking, and the future of global finance’ (2013) Central Banking, and the Future of Global Finance (November 5, 2013) Mehrling draws interesting parallels between the bills market of the late 19th century England and the current functioning of the shadow banking system.
83 Walter Bagehot, Lombard Street: A Description of the Money Market (H.S. King 1873)
84 Zoltan Pozsar, ‘Shadow Banking: The Money View’ (2014) Office of Financial Research Working Paper 7
85 These repos are collateralized by credit-safe public securities issued by dealers’ government bond trading desks.
86 These shares are backed by public assets but not by public liquidity and credit puts explicitly
87 These private securities could include instruments such as corporate bonds, issued by dealers’ credit trading desks
88 Pozsar, ‘Shadow Banking: The Money View’
In what follows, we study four typical mechanisms used to create money or quasi-money in the banking and shadow banking sector, they include:

1. Insurance (explicit or implicit government credit and liquidity puts, i.e., deposit insurance, LOLR, and bailouts);
2. Collateralization (repos, covered bonds, etc.);
3. Exemptions from bankruptcy laws (Repos);
4. Prudential requirement such as capital and liquidity requirements as well as portfolio restrictions for money-claim issuing entities.

Source: Pozsar (2014)
Insurance
There are three theories of banking as related to money creation. The ‘financial intermediation theory’ suggests that banks do not create money, the ‘fractional reserve theory’ of banking implies that although banks create money collectively through ‘multiple deposit expansion’ (the ‘money multiplier’), they do not individually create money, and the ‘credit creation theory of banking’ argues that each individual bank can create credit and money by granting a loan. In the credit creation theory of banking, what enables (commercial) banks to create money is their monopoly over taking deposit and lending simultaneously without any rule requiring them to segregate clients’ money. In this view of banking, “[D]eposits are not endowments that precede loan formation; it is loans that create deposits.” Evidence from the UK suggests that banks create and allocate approximately 97% of the money supply. In the fractional reserve theory and credit creation theory of banking, commercial banks would also create money through fractional reserve banking model. Fractional reserve banking entails risks. Since banks take demand deposits and at the same time commit not to recall loans at their whim, they are exposed to maturity mismatch. In addition, banks often find themselves funding illiquid assets by liquid liabilities and thereby exposed to liquidity mismatch. In short, banks engage in maturity and liquidity transformation carrying significant maturity mismatch risk. A bank that undertakes levered liquidity and maturity transformation, which along the way creates money, would need (government) safety nets, such as deposit insurance and liquidity support. In other words, the fragility of levered maturity transformation is the reason why banks are protected by a public safety net. Since the introduction of deposit

89 Under the financial intermediation theory, banks create money by receiving deposits first and lending them out. In the fractional reserve theory, banks create money by receiving new reserves first and by lending them out. Therefore, to create money under the financial intermediation theory, banks have to have deposits first. 
90 Richard A. Werner, ‘A lost century in economics: Three theories of banking and the conclusive evidence’ (2016) 46 International Review of Financial Analysis 361 
91 Richard A. Werner, ‘How do banks create money, and why can other firms not do the same? An explanation for the coexistence of lending and deposit-taking’ (2014) 36 International Review of Financial Analysis 71; Werner, ‘A lost century in economics: Three theories of banking and the conclusive evidence’; Richard A. Werner, ‘Can banks individually create money out of nothing? — The theories and the empirical evidence’ (2014) 36 International Review of Financial Analysis 1 
92 Claudio Borio, ‘The financial cycle and macroeconomics: What have we learnt?’ (2014) 45 Journal of Banking & Finance 182 This is also called endogenous money theory. See Basil Moore J., Horizontalists and verticalists: the macroeconomics of credit money (Cambridge University Press 1988); Nicholas Kaldor, The new monetarism (1970) 97 Lloyds Bank Review 18 
93 Michael; McLeay, Amar Radia and Ryland Thomas, ‘Money in the modern economy: an introduction’ (2014 Q1) Bank of England Quarterly Bulletin 2014 Q1 4; Michael; McLeay, Amar; Radia and Ryland Thomas, ‘Money creation in the modern economy’ (2014 Q1) Bank of England Quarterly Bulletin 2014 Q1 14; 
94 Deposit insurance as a means to achieve financial stability is a controversial issue. Many scholars argue that it would not overall protect financial stability. See: Asli Demirgüç-Kunt and Edward J. Kane, Deposit Insurance Around the Globe: Where Does It Work? (2002) 16 Journal of Economic Perspectives 175; Asli Demirgüç-Kunt, Edward Kane and Luc Laeven, Deposit insurance around the world: A comprehensive analysis and database’ (2015) 20 Journal of Financial Stability 155 
95 Bagehot, Lombard Street: A Description of the Money Market Some scholars advocate extending the safety net to shadow banking see: Mehring and others, ‘Bagehot was a shadow banker: shadow banking, central banking, and the future of global finance’, Morgan Ricks, The Money Problem: rethinking financial regulation (University of Chicago Press 2016)
insurance, there has been almost no serious runs by depositors on the banks of the developed world.\textsuperscript{96} Indeed, the only way banks can create money is by relying on the government safety nets. Although deposit insurance rests on risk-based contributions of banks to the deposit insurance funds, in the event of systemic risk, there is an implicit government guarantee for such funds (bailouts). The government itself relies on its fiscal powers (taxing) in bailouts, and its monopoly over issuing central bank money in its LOLR function.

The problem with insurance is that it often begets moral hazard, i.e., excessive money creation. It is to prevent such excessive money creation using public credit and liquidity puts that first structural or functional separation in the banking industry was proposed after the Great Depression. The most radical of all these proposals was the narrow banking proposal for a 100\% currency-reserve banking, put forward by Henry Simons.\textsuperscript{97} This proposal, along with his advocacy for equity financing versus debt financing, would effectively ensure that no non-banking institution would be able to create quasi-money instruments or money substitutes. In short, the proponents of narrow banks\textsuperscript{98} call for reforms that require all deposits of customers of a bank be held at central banks in the form of deposits, which is equivalent to 100\% reserve requirements. In other words, the amounts that can be redeemed at any time at par value should have 100\% reserve requirement. This proposal is part of the proposals that came to be known as the Chicago Plan in the aftermath of the Great Depression.\textsuperscript{99} At the heart of the narrow banking solutions to the banking crises is the separation of banks into two parts: A narrow bank offering deposits, and a mutual fund or investment company in which all the risks of volatility in the market value of assets pass through to the investors.

It is no surprise that such proposals resurfaced again in the aftermath of the global financial crisis (GFC) of 2007-2009. These proposals included a wide spectrum of recommendations ranging from narrow banking initiatives,\textsuperscript{100} ring fencing,\textsuperscript{101} prohibitions on proprietary trading by banking institutions coupled with putting limitations on their relationship with private funds.\textsuperscript{102} One could view the Volcker Rule and other

\begin{footnotesize}
\begin{itemize}
\item \textsuperscript{96} See Gorton, \textit{Slapped by the Invisible Hand: The Panic of 2007} 5 However, even in the recent global financial crisis, there were instances of runs on banks such as the run on the Northern Rock.
\item \textsuperscript{97} Henry C. Simons, \textit{A positive program for laissez faire} (Public Policy Pamphlet No 15, University of Chicago 1934); Henry C. Simons, ‘Rules versus Authorities in Monetary Policy’ (1936) 44 Journal of Political Economy 1
\item \textsuperscript{98} A narrow bank is defined as “a financial institution that issues demandable liabilities and invests in assets that have little or no nominal interest rate and credit risk.” George Pennacchi, ‘Narrow banking’ (2012) 4 Annual Review of Financial Economics 141 141
\item \textsuperscript{99} For a discussion of Chicago plan, see: Jaromir Benes and Michael Kumhof, \textit{The Chicago plan revisited} (International Monetary Fund Washington, DC 2012)
\item \textsuperscript{100} Biagio Bossone, ‘Should banks be narrowed?’ (2001) IMF Working Paper 23 Bossone views the Britain’s core banking model, or separation of commercial banking from investment banking, even within the same financial holding company as better alternatives to narrow banking.
\item \textsuperscript{101} See Matthias Lehmann, ‘Volcker rule, ring-fencing or separation of bank activities – Comparison of structural reform acts around the world’ (2016) 17 Journal of Banking Regulation 176; For the concept of ring-fencing, see: Steven L. Schwarz, ‘Ring-fencing’ (2013) 87 Southern California Law Review 69
\item \textsuperscript{102} Hossein Nabilou, ‘Bank Proprietary Trading and Investment in Private Funds: Is the Volcker Rule a Panacea or Yet Another Maginot Line?’ (2017) 32 Banking and Finance Law Review 297
\end{itemize}
\end{footnotesize}
structural reform measures as well as Section 23A and 23B of the U.S. Federal Reserve Act,\textsuperscript{103} as measures devised to curb excessive (quasi)money creation by the shadow banking sector relying on the government safety nets initially provided to banks; and thereby prevent the cross-subsidization of shadow banks.\textsuperscript{104}

**Bankruptcy safe harbors**

Cash as a bearer instrument is the ultimate means of settlement. The reason for cash having such a status is that it bears no counterparty risk. As soon as cash is tendered to discharge obligations, all the obligations of the borrower to the lender are instantaneously discharged. This means that cash and cash settlement is bankruptcy proof and carries no counterparty risks. Bankruptcy-proof nature of cash settlement helps cash become a safe and popular medium of exchange. For any other financial instrument that vies to become an ultimate medium of exchange and settlement, it should be, to the extent possible, free from counterparty risks.

The story of the transformation of repurchase agreement (repo) from a traditional old-style funding instrument to an effective shadow-banking-sector money can illustrate how removing counterparty credit risk can help transform a commonplace financial instrument to money. The savings glut starting from 2003,\textsuperscript{105} especially from China and the Middle-East, led to a sizeable demand for safe assets where those savings could be safely invested. This shift of the demand for safe assets, however, happened in a time when the supply of such assets was diminishing, especially in the U.S., where the government debt-to-GDP ratio was shrinking and a considerable amount of the U.S. government debt was retired. This shortage of safe assets prompted the private sector to create such assets, at a profit.\textsuperscript{106}

In addition to the savings glut hypothesis, the rise of professional asset management (mutual funds and pension funds) also generated a demand for safe assets for the optimal management of institutional investors’ cash balances.\textsuperscript{107} Since government credit puts are capped at amounts too low for institutional investors,\textsuperscript{108} and liquidity puts are restricted to banks, turning to traditional bank liabilities has not been an

\textsuperscript{103} 12 U.S.C. § 1851(f).
\textsuperscript{104} Nabilou, ‘Bank Proprietary Trading and Investment in Private Funds: Is the Volcker Rule a Panacea or Yet Another Maginot Line?’
\textsuperscript{105} Ben S. Bernanke and others, ‘International capital flows and the return to safe assets in the united states, 2003-2007’ (2011) FRB International Finance Discussion Paper
\textsuperscript{106} For the concept of safe assets, see International Monetary Fund, *Global Financial Stability Report: The Quest for Lasting Stability*, April 2012) 81 Safe assets are also described as “a variety of financial claims on public of private sector entities that are used as if they were risk-free.” See Anna Gelpern and Erik F. Gerding, *Rethinking the Law in “Safe Assets”* in Ross P. Buckley, Emilios Avgouleas and Douglas W. Arner (eds), *Reconceptualising Global Finance and Its Regulation* (Cambridge University Press 2016) 159 Gorton et al. describe safe assets as “information-insensitive” or “immune to adverse selection in trading because agents have no desire to acquire private information about the current health of the issuer”. See Gorton, Lewellen and Metrick, ‘The Safe-Asset Share’ 101
\textsuperscript{107} Zoltan Potzser and Manmohan Singh, ‘The nonbank-bank nexus and the shadow banking system’ (2011) IMF Working Papers 1
\textsuperscript{108} Currently, the amount insured by the FDIC is $250,000, and in the EU it is €100,000. See Art. 6(1) of the Directive 2014/49/EU of the European Parliament and of the Council of 16 April 2014 on deposit guarantee schemes Text with EEA relevance, *OJ L 173,*
option for institutional investors, even in the presence of brokered deposits.\textsuperscript{109}

Despite the fact that shadow banks cannot rely on the banks’ safety net and are susceptible to runs,\textsuperscript{110} by creating safe, short-term, and liquid instruments (quasi money) from risky, long-term and illiquid assets, they nevertheless responded to the excess demand for safe assets. A large amount of creation of these assets were conducted using securitization, repos,\textsuperscript{111} and extensive use of credit derivatives, replacing government guarantees by implicit or explicit private sector guarantees.\textsuperscript{112} However, repo, which, thanks to over-collateralization (i.e., a haircut on the market value of the collateral) and the short maturity, provides an efficient substitute for demand deposits and a means of short-term market funding, stands out. Unlike bank deposits, the repos’ safety does not depend on the amount of the contract, therefore, they are suitable for the cash-management needs of institutional investors.\textsuperscript{113}

An analogy of cryptocurrencies with money markets dominated by repos can shed some light on the issue, as the prime driver of repos in the money markets has been the quest for safe assets. To increase the safety of an asset and use it as money, banks resorted to repos to provide short-term (overnight) investment opportunities for investment funds and, in the meantime, create an incredibly efficient source of funding and liquidity for themselves. Repos essentially replicated the function of demand deposits, with an additional safety due to its secured nature. In a short period of time, the use of repo for interbank and institutional financing arrangement became so popular that it effectively became the “oil in the engine of the global banking network”\textsuperscript{114} and a substitute for bank deposits for institutional investors.\textsuperscript{115} One important aspect of enhancing safety feature of repos lies in the repo’s preferential treatment in bankruptcy.

The U.S. Bankruptcy Code affords special treatment to Qualified Financial Contracts (QFCs) (including

\textsuperscript{109} Demirgüç-Kunt, Kane and Laeven, 'Deposit insurance around the world: A comprehensive analysis and database'

\textsuperscript{10} Brokered deposits are also called jumbo deposits. FDIC defines a brokered deposit as “any deposit accepted by an insured depository institution from or through a third party, such as a person or company or organization other than the owner of the deposit.” See Federal Deposit Insurance Corporation, \textit{Guidance on Identifying, Accepting, and Reporting Brokered Deposits: Frequently Asked Questions} (2014) Deposit brokerage has evolved to circumvent the upper limits on covered deposits. See Mark D. Vaughan and Timothy J. Yeager, "Cedars” deposits: will they fly?" (2003) The Regional Economist 10

\textsuperscript{111} A repo or repurchase agreement is the sale of securities coupled with a commitment to repurchase them at a specified price and at a future date or on demand. See Tobias Adrian and others, Repo and Securities Lending’ (2012) NBER Working Paper Series 2

\textsuperscript{112} In the GFC, the run on repos, which led to forced deleveraging, played a significant role in the crisis. See Gary B. Gorton and Andrew Metrick, ‘Securitized Banking and the Run on Repo’ (2012) 104 Journal of Financial Economics 425; Gorton, \textit{Slapped by the Invisible Hand: The Panic of 2007}

\textsuperscript{113} According to Haldane, the size of the global asset management industry is some $87 trillion. See Andrew G. Haldane, 'The age of asset management?' (2014) 4 Speech at the London Business School

\textsuperscript{114} Robert Guttman, \textit{Finance-Led Capitalism: Shadow Banking, Re-Regulation, and the Future of Global Markets} (Palgrave Macmillan 2016) 133

\textsuperscript{115} Swati Ghosh, Ines Gonzalez del Mazo and İnci Ötker-Robe, ‘Chasing the shadows: How significant is shadow banking in emerging markets?’ (2012) The World Bank- Economic Premise 1 2
derivatives and repos) by exempting them from the ‘automatic stay’ and allowing counterparties to terminate these contracts (by closing out, netting or setting off their derivatives positions) and to seize the underlying collateral. The equivalent of such preferential treatment is also adopted in Europe as part of the Financial Collateral Directive. Therefore, the collateral of a repo is exempted from the automatic stay on the borrower’s assets in case of bankruptcy across major jurisdictions. This has substantially reduced the counterparty risks in repo transactions.

Bankruptcy safe harbours for repos played an important role in the growth of shadow banking. The underlying rationale for this safe harbour for derivatives and repos was that the repo and derivatives markets can be a source of systemic risk and this exemption (netting and close-out) would be necessary to prevent the risks of contagion. However, after the GFC, the safe harbour provisions for repos have become highly controversial. It is argued that such safe harbours fuel fire sales and collateral crises. Further studies suggest that the role of closeout and netting in reducing systemic risk is far from straightforward.

Recently, after much debate about the advantages and disadvantages of the bankruptcy safe harbours, there has been regulatory proposals to change the treatment of derivatives and repos in bankruptcy. For example, there has been recommendations to impose a temporary stay on close-out netting for a short period of time (48h or until 5pm of the next business day). Such a temporary stay would allow for benefiting from the risk-mitigation advantage of close-out netting while preventing fire sales. However, any modification beyond that has not gained considerable traction. This proposal has already been implemented in Europe by the Bank Recovery and Resolution Directive (BRRD) amending the Financial Collateral Directive (FCD). However, the impact of this amendment on repo markets remains to be seen.

In general, removing the automatic stay exception would act as a curb on repos by reducing the liquidity of the collateral, particularly in tri-party markets. This can be viewed as a sensible regulatory measure to

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116 The Safe Harbor Provisions are embedded in the following provisions: 11 U.S.C. §§ 362(b)(6), 362(b)(7), 362(b)(17), 546, 556, 559, 560 & 561 (2012). In Europe, such safe harbors are granted in the financial collateral directive (FCD) art. 8.

117 Directive 2002/47/EC on financial collateral arrangements [2002] OJ L168/43, as amended by Directive 2009/44/EC [2009] OJ L146/37 and Directive 2014/59/EU [2014] OJ L173/190.

118 Gary B. Gorton and Andrew Metrick, ‘Regulating the Shadow Banking System’ (2010) Brookings Papers on Economic Activity 261 266

119 See for example, René M. Stulz, ‘Should We Fear Derivatives?’ (2004) 18 The Journal of Economic Perspectives 173 188

120 Carolyn Sissoko, ‘The legal foundations of financial collapse’ (2010) 2 Journal of Financial Economic Policy 5 See also Steven L. Schwarz, ‘Derivatives and collateral: Balancing remedies and systemic risk’ (2015) 2015 University of Illinois Law Review 699

121 Robert R. Bliss and George G. Kaufman, ‘Derivatives and systemic risk: Netting, collateral, and closeout’ (2006) 2 Journal of Financial Stability 55

122 Philipp Paech, Shadow banking: legal issues of collateral assets and insolvency law, 2013) 5 See, David A. Skeel and Thomas H. Jackson, ‘Transaction consistency and the new finance in bankruptcy’ (2012) 112 Columbia Law Review 152 Other commentators believe that the safe harbors should be removed even for such instruments. See Norbert J. Michel, Fixing the Regulatory Framework for Derivatives, 2016

123 See, BBRD, arts. 70-71 and 118 that revises the FCD by inserting a new article 1(6) to that directive.

124 Nathan Goralnik, ‘Bankruptcy-Proof Finance and the Supply of Liquidity’ (2012) 122 Yale Law Journal 460
reduce the reliance on lower-quality collateral, akin to setting minimum haircuts. However, removing this exception would probably be unwarranted for higher-quality collateral, such as most government-guaranteed securities. As the most important impact of such bankruptcy safe harbours for repo collateral is that they enhanced the safety of repo to be used in (interbank) financial transactions as money, removing such exemptions for lower quality collateral would erode the moneyness of repos and place a curb on (quasi)moneyness creation by shadow banks.

**Microprudential measures: Portfolio restrictions, leverage and liquidity requirements**

Money Market Funds (MMFs) are financial intermediaries that connect short-term debt issuers with providers of funds who need daily liquidity. Starting from the 1970s, in the U.S., financial products developed by MMFs, called NOW accounts (Negotiable Order of Withdrawal), were widely accepted as a direct substitute to bank deposits. Currently, CNAV MMFs are effective substitutes for insured deposits, and provide continuous liquidity for those institutional investors that have surplus funds and need daily liquidity.

Since claims on MMFs are virtually redeemable at par on demand, they are money (M2). The Securities and Exchange Commission (SEC) and the Office of the Comptroller of the Currency (OCC) have adopted measures on the reform of the MMFs and short-term investment funds (STIFs) to address the risk of run on such entities. SEC’s reforms have so far focused on reducing risk on the asset side of MMFs’ balance sheet. These reforms require a minimum percentage of assets to be held in highly liquid securities (daily and weekly requirements), they further impose restrictions on the purchase of lower quality securities by MMFs.

In addition, the SEC rules treat government MMFs (that invest at least 80% of their assets in U.S. government debt) and prime MMFs (that invest in corporate debt) differently. These rules require that government MMFs can maintain stable price per share (CNAV), but the prime MMFs should adopt the Variable Net Asset Value (VNAV) pricing model. To be more precise, according to the SEC’s 2014 revisions to the regime governing MMFs, there will be three different categories of MMFs: retail

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125 See Nabilou and Pacces, ‘The Law and Economics of Shadow Banking’. A rather different proposal comes from Acharya and Öncü who propose creating a special resolution authority called ‘Repo Resolution Authority’ (RRA) for addressing the potential systemic risks of repo collateral fire sales during a financial crisis. They advocate removing the bankruptcy safe harbor (except for high quality government bonds). And in case of a default by a counterparty on a repo, the RRA would make a liquidity payment to repo lenders and then will try to liquidate the collateral in an orderly manner. In this case, an ex-ante fee should be charged on the repo lenders. They also propose that there should also be certain eligibility criteria on such repo lenders. Viral V. Acharya and T. Sabri Öncü, ‘A Proposal for the Resolution of Systemically Important Assets and Liabilities: The Case of the Repo Market’ (2013) 9 International Journal of Central Banking 291

126 In doing so, MMFs can become subject to runs due to their engagement in liquidity - and to a lesser extend maturity - transformation without access to government safety nets.

127 Financial Stability Oversight Council, *Financial Stability Oversight Council (FSOC) 2016 Annual Report*, 2016 111
(prime/municipal) MMFs, institutional (prime/municipal) MMFs, and government MMFs. Retail (prime/municipal) MMFs will be priced daily, at CNAV of $1.00, and will be available to natural persons only. Institutions, businesses, and other organizations are not eligible to invest in these types of funds. They are required to impose liquidity fees and or redemption gates. Institutional Prime/municipal MMFs will be priced daily at VNAV. All categories of investors are eligible to invest in these types of funds. They are required to impose liquidity fees or redemption gates. And government MMFs that will be priced daily at CNAV, and there will be no restrictions on eligible investors. These MMFs can impose redemption or liquidity fees and/or they can suspend all fund redemption (aka redemption gates).128

Similar measures were put in place in 2017 in Europe.129 The EU MMF Regulation recognizes three different types of MMFs. VNAV MMFs, public debt CNAV MMFs and Low volatility NAV MMFs (LVNAV MMFs).130 This regulation imposes certain levels of daily/weekly liquidity (portfolio rules) on both short-term MMFs131 and standard MMFs.132 The LNAV and public debt CNAV funds are required to hold at least 10% of their assets in instruments that mature on a daily basis133 and an additional 30% of their assets maturing in a week.134 These liquidity requirements are imposed to ensure that investor redemption could be satisfied in a timely fashion. As it is clear, the main reason behind these new regulatory developments has been to limit ‘private’ quasi-money creation by MMFs, while allowing such quasi-money creation for funds investing in government bonds. In effect, this suggests that the ultimate source of safety of such privately-created quasi money is from the government.

Collateralization
An additional private innovation, which has played a major role in enhancing the safety of assets, is collateralization, which has reached its zenith in the production of covered bonds. Covered bonds are bonds (debt securities) secured by high-quality collateral. In addition to the over-collateralized cover pool, investors in covered bonds have an unsecured recourse against the issuer in the event of collateral deficiency (dual recourse). Cover-pool assets, which are ring-fenced to protect investors in the event of the bankruptcy of the issuer (bankruptcy remoteness of the cover pool), remain on the balance sheet of the issuer. Furthermore, the weak assets in the cover pool is constantly replaced by high-quality assets throughout the

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128 Retail funds will be available only to natural persons (individuals, certain trusts and retirement accounts).
129 Regulation (EU) 2017/1131 of the European Parliament and of the Council of 14 June 2017 on money market funds OJ L 169, 30.6.2017, p. 8–45, hereinafter EU MMFs Regulation
130 Art. 3 of the EU MMFs Regulation.
131 Art. 24 of the EU MMFs Regulation.
132 Art. 25 of the EU MMFs Regulation.
133 Art. 24 (c) of the EU MMFs Regulation.
134 Art. 24 (e) of the EU MMFs Regulation.
life of the bond (dynamic cover-pool). In addition to all of the above advantages, bankruptcy laws and regulations such as the BRRD and the Single Resolution Mechanism (SRM) Regulation exempt covered bonds from its bail-in provisions, which essentially constitutes a regulatory subsidy for covered bonds. All these features make covered bonds a high-yielding and attractive alternative to government securities.

Covered bonds are not different from securitization in essence, in the sense that they are trying to create safe assets using private sources of safety. Such funds, if sufficiently information insensitive, can play the role of money in the financial markets by becoming a safe collateral against which borrowing would be made possible.

All in all, shares or bonds in money market funds, repos and to a lesser degree covered bonds can be viewed as quasi-money. All of the above mechanisms for money creation rely on a set of complex instruments enhancing information insensitivity of money created by banks and shadow banks. However, all of the above sources of safety and money and quasi-money creation mechanisms share a common feature in that they are directly or indirectly linked to governments as the ultimate credit and liquidity put providers.

To summarize, the shadow banking sector engages in money creation by turning information-sensitive assets into information-insensitive ones by using insurance, collateralization, taking advantage of prudential regulation, and preferential regulatory treatment in bankruptcy. As it is clear by now, money creation in shadow banking in most parts has been a public-private endeavour. As we sketched the main mechanisms of the public-private money creation in the banking and shadow banking sector, now it is time to ask what creates safety or information insensitivity for central bank money, which is considered to be the safest asset in the financial system and the ultimate means of settlement in payment and settlement systems.

**Information asymmetry and central bank money**

Ideally, to become money, a debt instrument should be above suspicion and beyond doubt as to the value of the underlying collateral. However, no debt instrument is risk-free. Any financial claim, including central bank money, carries a certain degree of counterparty risk. Governments have managed to get around such a credit risk in an unorthodox fashion. The residual information insensitivity of fiat currencies has been

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135 Steven L. Schwarcz, ‘The conundrum of covered bonds’ (2011) The Business Lawyer 561 566
136 Art. 44(2)(b) of the Directive 2014/59/EU of the European Parliament and of the Council of 15 May 2014 establishing a framework for the recovery and resolution of credit institutions and investment firms and amending Council Directive 82/891/EEC, and Directives 2001/24/EC, 2002/47/EC, 2004/25/EC, 2005/56/EC, 2007/36/EC, 2011/35/EU, 2012/30/EU and 2013/36/EU, and Regulations (EU) No 1093/2010 and (EU) No 648/2012, of the European Parliament and of the Council OJ L 173, 12.6.2014, (BRRD) & Art. 27(3)(b) of the SRM Regulation. Regulation (EU) No 806/2014 of the European Parliament and of the Council of 15 July 2014 establishing uniform rules and a uniform procedure for the resolution of credit institutions and certain investment firms in the framework of a Single Resolution Mechanism and a Single Resolution Fund and amending Regulation (EU) No 1093/2010, OJ L 225, 30.7.2014, p. 1–90,
137 Frank Packer, Ryan Stever and Christian Upper, ‘The covered bond market’ (September 2007) BIS Quarterly Review 45
eliminated by making all financial market participants ‘symmetrically ignorant’ of the value of the collateral (a promise to pay). As Homlstrom puts:

“Money itself is very opaque about the underlying collateral. No one knows what exactly backs up government issued money. “The full faith and credit of the government” is a very vague promise. But the beauty of money is that even if I do not know the exact value of the collateral backing my government’s promise, neither does anyone else. So we are “symmetrically ignorant” – a blissful state in money markets.”

Therefore, in contrast to the view that holds that the common knowledge in transactions is provided by central banks or their equivalents (reducing or removing adverse selection problem), in fact, governments have chosen a certain degree of obscurity and obfuscation in order to remove the incentives for people to acquire information about the true value of money and its underlying collateral. Indeed, a level of symmetric (rational) ignorance is needed in order for the people to accept a debt instrument as a medium of exchange or a store of value. This symmetric ignorance removes all the incentives to acquire information about the underlying collateral.

With the exception of a few prominent legal works on money and monetary issues, any jurist of banking and financial law would attest that there is a clear scarcity of jurisprudence or legal literature on money. In an artificially created symmetrically ignorant world, this should not come as a surprise. This is perhaps because money, if questioned, would cease to be money. In the words of Kreitner, “[p]erhaps money does work best when it is forgotten, taken for granted. Or at least, perhaps that is the way it works best for people who have it.” In other words, we are all better off if we forget about the underlying collateral of money.

**The price tag of relying on symmetric ignorance**

The safety feature arising from a secured debt contract comes with a price tag. A shock to the value of the underlying collateral that would cause an information-insensitive debt to become information sensitive can have a disruptive impact and unleash a full-fledged financial crisis. Such a shock would either provoke information acquisition (leading to adverse selection) resulting in the likely collapse of the market for debt, or it would provoke no incentive for information acquisition. In the latter case, instead of information acquisition, market participant would only be willing to trade at a price lower than the fundamental value

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138 Holmstrom, 'Understanding the role of debt in the financial system'
139 Isabel Schnabel and Hyun Song Shin, 'Money and trust: lessons from the 1620s for money in the digital age' (2018) BIS Working Paper No 698
140 See for example: Proctor, *Mann on the Legal aspect of money*
141 Roy Kreitner, 'Legal History of Money' (2012) 8 Annual Review of Law and Social Science 415
142 ibid
143 Dang, Gorton and Holmström, 'Ignorance, debt and financial crises'
of the debt instruments, which again would lead to write-downs and fire sales. Both scenarios are likely to result in financial crises.  

Compared to equity markets, money claimants respond differently from equity claimants to new information. Unlike equity markets in which equity prices respond to new information in an incremental fashion, money markets often respond to new information non-linearly and in a precipitous manner. In other words, new information can lead to a collapse of trade in debt funding market and can be a discontinuous event, creating a cliff-effect. This is perhaps why financial crises often involved debt markets. This has been documented in the GFC in the run on repos backed by structured securities (private money à la Pozsar). In the repo markets, due to lower appetite for liquidity and credit risks, triparty repo investors (mainly MMFs) often pre-emptively withdraw funding at an early stage. This feature of money gives it a special attribute. Debt-based money becomes a binary, either-or phenomenon.

However, most cryptocurrencies, specially bitcoin, are more akin to commodities than currencies. This makes bitcoin similar to a commodity money. Compared to debt instruments, a commodity has even a bumpier road to becoming money. Unlike fiat money, whose value depends on the full faith and credit of governments, to be viable, commodity money, as a self-anchored money, needs to build consensus among its users to become a viable store of value or a medium of exchange. And arriving at such a consensus can take centuries or more, as was the case with gold or silver.

In the absence of a credible obligor (i.e., central authority, underwriter, debtor), building consensus around a commodity money would require it to display certain properties to assure the users that it possesses certain intrinsic value. In the absence of intrinsic value, the value (if any) of commodity money is prone to wild fluctuations. In case of bitcoin, this may be due to the increased information sensitivity coming from the user sentiment and fluctuations in the network value of the coin or even potential security vulnerabilities. Such levels of information sensitivity would be a major obstacle in the path to becoming a viable medium

144 ibid
145 See: Adam M Copeland, Antoine Martin and Michael Walker, ‘The tri-party repo market before the 2010 reforms’ (2010) FRB of New York Staff Report 3; Kathryn Judge, ‘Information Gaps and Shadow Banking’ (2016) 103 Virginia Law Review (forthcoming) 31
146 Dang, Gorton and Holmström, ‘Ignorance, debt and financial crises’
147 Gorton and Metrick, ‘Securitized Banking and the Run on Repo’ See also: Gorton, Slapped by the Invisible Hand: The Panic of 2007
148 In this sense, the repos as debt instruments, reflect the features of money (information insensitivity), see: Judge, ‘Information Gaps and Shadow Banking’; See also: Dang, Gorton and Holmström, ‘Ignorance, debt and financial crises’; Gorton, The development of opacity in U.S. banking’; In other words, holders of money claims, either have faith in it completely, or will lose it completely and switch to something else for a medium of exchange, store of value or unit of account. This has been seen in many countries in which there has been periods of high inflation. Dollarization in Zimbabwe was a prominent example of such a phenomenon.
149 Even in the presence of intrinsic value, such volatility would persist due to the fixed supply schedule of bitcoin which makes its price volatile in the presence of demand shocks.
of exchange, an effective store of value or a unit of account. Without such assurances, a run would easily occur upon a discovery of new information as of the value of a commodity money. In case of bitcoin, its digital nature and its global reach has helped it gain momentum and become a consensus-based store of value and a medium of exchange in a relatively short time span. However, to become a long-term store of value, bitcoin needs to be information insensitive.

Nonetheless, there is a difference between information insensitivity stemming from exogenous shocks/information and that originating from endogenous shocks. As of this writing, bitcoin has been extremely sensitive to exogenous information or shocks. Even trivial positive information, such as listing in an exchange, has doubled or tripled its price in a relatively short time span. On the other hand, negative information (such as a hack of an exchange) has also had a disproportionate negative impact on its price and increased its volatility by orders of magnitude unheard of in traditional assets markets. However, seldom could these wild fluctuations be attributable to the endogenous shocks of information about the Bitcoin Blockchain itself; with a few exceptions such as the scalability debate, which occurred in November 2017, that had a rather benign impact on the pricing. The extreme price volatility stemming from exogenous shocks can also be a sign of the youth and immaturity of an asset. And it is not to say that in the future, volatility and information sensitivity of bitcoin cannot be mitigated by market forces. As data suggest volatility of bitcoin has been decreasing significantly over time.

150 For a concise illustration of the debate, see: Laura Shin, *Will This Battle For The Soul Of Bitcoin Destroy It?* (Oct. 23, 2017)
In what follows, we argue that informational attributes of bitcoin are superior to that of fiat money. This informational edge of bitcoin would likely reduce bitcoin volatility with orders of magnitude far smaller than what we witness today.

Fiat money vs. bitcoin: Symmetric ignorance vs. common knowledge

Does the information economics of debt-based money apply to a (digital/synthetic) commodity money (bitcoin)? The history suggests that commodity money is also not immune to perils of information economics. As for gold, its price is dependent on its scarcity. News related to the mining and discovery of gold would have a positive or negative impact on the price of gold. This has happened several times in history (e.g., California gold rush). At its extreme, a discovery of large swathe of gold would diminish its value as a store of value and put its moneyness at risk. However, gold itself is a self-anchored simple product and as such its value is not dependent on any endogenous shocks.

It appears that bitcoin has also taken a different path from that of fiat money with regard to its information economics. This path is very similar to that of gold. Although, unlike gold, bitcoin is a complex product, its high level of transparency, originating from its open-source nature, makes all endogenous information

Source: https://www.buybitcoinworldwide.com/volatility-index/
available to all users. Indeed, unlike fiat money, transparency is at the heart of bitcoin. The issuing (how, what and how many), peer-to-peer nature, mining process, verification and confirmation of transactions are all common knowledge. The functioning of bitcoin and Bitcoin Blockchain is completely transparent and is laid out in Satoshi’s whitepaper.\(^1\) There is a predefined supply schedule and the open ledger of bitcoin is out in the public eye and everyone with internet connection has access to all the data and transactions being processed on the Bitcoin Blockchain. Hence, there seems to be no information with regard to bitcoin the revelation of which could cause a dramatic increase or a collapse in the value of bitcoin. In this regard, unlike fiat money, which is built on symmetric ignorance, bitcoin is built on common (symmetric) knowledge. Bitcoin does not hide any information by creating endogenous vagueness. In other words, transparency is endogenous to bitcoin.\(^2\) By design, the transparency level of bitcoin is so high that it discourages any attempt to acquire private information about the value of bitcoin, making it an adverse-selection proof instrument and a viable instrument to become an ultimate means of settlement.

Since ignorance can be turned into knowledge, but knowledge cannot be reversed back into ignorance, an instrument, which is based on common knowledge, has an advantage on an instrument which is based on symmetric ignorance. Hence, bitcoin enjoys a higher level of information insensitivity. This in turn means that bitcoin does not have to pay the price of symmetric-ignorance-based information insensitivity, i.e. a precipitous run. This gives bitcoin an edge compared to fiat money and can potentially make it as a safe store of value and a hedge against risks in times of financial market turbulence when financial market participants have to fly to safety.

It appears that this high level of transparency in the Bitcoin Blockchain has been the most significant factor contributing to building trust among the early adopters and has paved the way to its incredibly fast adoption. Unlike fiat money to which transparency (symmetric knowledge) is a bane; to bitcoin, it turned out to be a boon. Only against this background of symmetric ignorance does the value of bitcoin become clear. Indeed, creating a consensus that something without a physical form has value and can be used as a currency without relying on trusted third parties is by far one of the greatest success stories in monetary history.\(^3\)

In addition to that superior informational advantage, bitcoin possess several other advantages against fiat money. The digital nature, superior safety features based on PoW, properties such as resistance to double spending, forge-proof, tamper-proof and immutability, censorship resistance, pseudonymity, cheaper

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\(^1\) Nakamoto, *Bitcoin: A peer-to-peer electronic cash system*

\(^2\) However, bitcoin can be and still is vulnerable to external or exogenous information or shocks. For example, any news about 51% attack, advances in quantum computing – which may or may not affect the bitcoin security, can cause mayhem in bitcoin valuation markets.

\(^3\) Burniske and Tatar, *Cryptoassets: The Innovative Investor’s Guide to Bitcoin and Beyond Chapter 4.*
transaction costs, and decentralized, trustless trust nature of bitcoin all give an edge to bitcoin compared to central bank money, making it a viable cryptocurrency in the long run.

Despite its superior informational attributes, it is highly unlikely that bitcoin would be accepted as a single base money within a single currency area due to its inelastic or fixed supply schedule, which removes monetary policy flexibility needed both in times of calm and crises. It is also unlikely that bitcoin would be a substitute for commercial bank money, as the latter has its own advantages serving various needs of a given economy. However, there is a likelihood of bitcoin becoming a parallel and concurrent currency exerting competitive pressure on the central bank money.\(^\text{154}\) As the development of banking and shadow banking around bitcoin cannot be ruled out, bitcoin may in the future directly compete against commercial bank, as well as shadow banking money.

**Summary and conclusion**

Having compared the information economics of bitcoin to that of central bank money, commercial bank money and shadow banking money, this paper concludes that bitcoin has the potential to become a viable store of value, a unit of account, and a medium of exchange. Although regulators on both sides of the Atlantic have taken a passive approach to regulating cryptocurrencies, with the increasing popularity and potential success of cryptocurrency experiments, it is likely that governments would involve in regulating cryptocurrencies in the foreseeable future. This paper highlights certain aspects of information economics in cryptocurrency as well as fiat-money ecosystems that would inform any pending regulatory intervention in cryptocurrency ecosystem.

The main contribution of this paper lies in the lessons drawn from the literature on shadow banking, safe assets and information economics. Cryptocurrencies are not the first example of non-governmental or private money creation. Even within the current financial system, a large portion of monetary aggregates (including parts of M1, M2, and M3) consists of private or quasi-private money (e.g., bank deposits, claims on government and prime CNAV MMFs, etc.)

Shadow banking has long been in the business of quasi-money issuance, and safe-asset debate lies at the heart of money creation within the shadow banking system. For an asset to be safe, it needs to be information insensitive. The main techniques used to create information insensitive assets in the banking and shadow banking system have been insurance, (over)collateralization, imposing prudential requirements on issuing entities, and preferential regulatory treatment of quasi-money instruments (bankruptcy safe

\(^{154}\) Raskin and Yermack, *Digital Currencies, Decentralized Ledgers, and the Future of Central Banking*
harbours for repos). In all these cases, the value of an external element (e.g., collateral in repos, government credit and liquidity puts in deposits) removes the depositors’ or investors’ incentives to acquire information about the underlying debt contract, making it information insensitive. Although the safest asset in the financial system (central bank money) is a debt contract, the underlying collateral of central bank money is a vague and abstract promise (full faith and credit of the relevant government). The symmetric ignorance of all market participants as to the value and nature of that collateral (full faith and credit) removes any incentive for participants to acquire information about the underlying collateral (hence a state of blissful symmetric ignorance). Therefore, information insensitivity of fiat money is built upon the symmetric ignorance of the underlying collateral.

The information economics and potential information insensitivity of bitcoin, however, stands at stark contrast to that of fiat money, as bitcoin relies on symmetric (common) knowledge of the underlying inner workings of the Bitcoin Blockchain. The proposition that ignorance can be turned into knowledge, but knowledge cannot be reversed back into ignorance is central to the information insensitivity of bitcoin. Full transparency in the Bitcoin Blockchain eliminates incentives to acquire new information, thereby eliminating the adverse-selection problem arising from information asymmetry as to the value of bitcoin as a medium of exchange. The superior informational features of bitcoin make it a potential safe asset, a good store of value, a medium of exchange, and possibly a unit of account. More importantly, this feature, along with apolitical nature of bitcoin, would put it in a far superior position, compared to fiat currencies, as an ultimate means of settlement in international retail and wholesale payment and settlement systems.

This important finding has significant implications for regulating cryptocurrencies. Given the potential promises of bitcoin and its superior properties in terms of its information economics, public policy should allow for the organic and market-driven growth of bitcoin, which is by far one of the greatest experiments in the monetary history. Since the cryptocurrency ecosystem is in its infancy, a hard-touch regulatory approach can hinder the potential welfare-enhancing innovations coming from this ecosystem. However, this suggestion should not be mistaken for an advocacy of regulatory faineance, as the development of the ecosystem suffers from legal uncertainty. To the contrary, this approach is a defence of regulatory sobriety, data dependency, and a deference to the virtues of experimentation, permissionless innovation, spontaneous discovery process and evolutionary dynamics in the financial system.

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155 Israel M. Kirzner, 'The Perils of Regulation: A Market-Process Approach', in Israel M. Kirzner (ed), Discovery and the Capitalist Process (University of Chicago Press 1985)

156 Simon A. Levin and Andrew W. Lo, 'Opinion: A new approach to financial regulation' (2015) 112 Proceedings of the National Academy of Sciences 12543
Bibliography

- Acharya VV and Öncü TS, 'A Proposal for the Resolution of Systemically Important Assets and Liabilities: The Case of the Repo Market' (2013) 9 International Journal of Central Banking 291
- Adrian T and others, 'Repo and Securities Lending' (2012) NBER Working Paper Series
- Akerlof GA, 'The Market for “Lemons”: Quality Uncertainty and the Market Mechanism' (1970) 84 The Quarterly Journal of Economics 488
- Bagehot W, 'The General Aspect of the Banking Question' in St John Stevas N (ed), The Collected Works of Walter Bagehot, vol 9 (The Economist 1857)
- Bagehot W, Lombard Street: A Description of the Money Market (H.S. King 1873)
- Bech M and Grarratt R, 'Central Bank Cryptocurrencies' (2017) BIS Quarterly Review
- Benes J and Kumhof M, The Chicago plan revisited (International Monetary Fund Washington, DC 2012)
- Berentsen A and Schär F, 'A Short Introduction to the World of Cryptocurrencies' (First Quarter 2018) 100 Federal Reserve Bank of St Louis Review 1
- Bernanke BS and others, 'International capital flows and the return to safe assets in the united states, 2003-2007' (2011) FRB International Finance Discussion Paper
- Bliss RR and Kaufman GG, 'Derivatives and systemic risk: Netting, collateral, and closeout' (2006) 2 Journal of Financial Stability 55
- Borio C, 'The financial cycle and macroeconomics: What have we learnt?' (2014) 45 Journal of Banking & Finance 182
- Bossone B, 'Should banks be narrowed?' (2001) IMF Working Paper
- Brunnermeier MK and Pedersen LH, 'Market Liquidity and Funding Liquidity' (2009) 22 The Review of Financial Studies 2201
- Bryan MF, 'Island Money' (2004) Federal Reserve Bank of Cleveland, Economic Commentary
- Burniske C and Tatar J, Cryptoassets: The Innovative Investor's Guide to Bitcoin and Beyond (McGraw Hill 2018)
- Chaum D, 'Security without identification: Transaction systems to make big brother obsolete' (1985) 28 Communications of the ACM 1030
- Commodity Futures Trading Commission, In the Matter of: Coinflip, Inc., d/b/a Derivabit, and Francisco Riordan, Respondents: Order instituting proceedings pursuant to sections 6(c) and 6(d) of the commodity exchange act, making findings and imposing remedial sanctions (CFTC Docket No. 15-29) (September 17, 2015)
- Copeland AM, Martin A and Walker M, 'The tri-party repo market before the 2010 reforms' (2010) FRB of New York Staff Report
- Corporation FDI, Guidance on Identifying, Accepting, and Reporting Brokered Deposits: Frequently Asked Questions (2014)
- Council FSO, Financial Stability Oversight Council (FSOC) 2016 Annual Report, 2016
- Dang TV, Gorton G and Holmström B, 'Ignorance, debt and financial crises' (2012) Yale University and Massachusetts Institute of Technology, working paper
DeLong JB, 'This Time, It Is Not Different: The Persistent Concerns of Financial Macroeconomics' in Blinder AS, Lo AW and Solow RW (eds), Rethinking the Financial Crisis (Russell Sage Foundation and the Century Foundation 2012)

DeMarzo PM, Kremer I and Skrzypacz A, 'Bidding with Securities: Auctions and Security Design' (2005) 95 American Economic Review 936

Demirgüç-Kunt A, Kane E and Laeven L, 'Deposit insurance around the world: A comprehensive analysis and database' (2015) 20 Journal of Financial Stability 155

Demirgüç-Kunt A and Kane EJ, 'Deposit Insurance Around the Globe: Where Does It Work?' (2002) 16 Journal of Economic Perspectives 175

Economist T, The promise of the blockchain: The trust machine' (2015)

European Central Bank, 'Virtual currency schemes- a further analysis' (2015)

Europol, Massive blow to criminal dark web activities after globally coordinated operation (20 July 2017)

Friedman M, 'The Island of Stone Money' (1991) The Hoover Institution Working Papers in Economics E-91-3

Gelpern A and Gerding EF, 'Rethinking the Law in "Safe Assets"' in Buckley RP, Avgouleas E and Arner DW (eds), Reconceptualising Global Finance and Its Regulation (Cambridge University Press 2016)

Geva B, 'Disintermediating Electronic Payments: Digital Cash and Virtual Currencies' (2017) 13 Journal of International Banking Law and Regulation

Ghosh S, Gonzalez del Mazo I and Ötker-Robe İ, 'Chasing the shadows: How significant is shadow banking in emerging markets?' (2012) The World Bank- Economic Premise 1

Goralnik N, 'Bankruptcy-Proof Finance and the Supply of Liquidity' (2012) 122 Yale Law Journal 460

Gorton G, 'The development of opacity in U.S. banking' (2013) 31 Yale Journal on Regulation 825

Gorton G, Shadow Banking (Federal Reserve Bank of Minneapolis December 2010)

Gorton G, Lewellen S and Metrick A, 'The Safe-Asset Share' (2012) 102 The American Economic Review 101

Gorton GB, Slapped by the Invisible Hand: The Panic of 2007 (Oxford University Press 2010)

Gorton GB and Metrick A, 'Regulating the Shadow Banking System' (2010) Brookings Papers on Economic Activity 261

Gorton GB and Metrick A, 'Securitized Banking and the Run on Repo' (2012) 104 Journal of Financial Economics 425

Graeber D, Debt: the first 5,000 years (Melville House Publishing 2011)

Greenberg A, Silk Road Mastermind Ross Ulbricht Convicted of All 7 Charges (April 02, 2015)

Guttmann R, Finance-Led Capitalism: Shadow Banking, Re-Regulation, and the Future of Global Markets (Palgrave Macmillan 2016)

Haldane AG, 'The age of asset management?' (2014) 4 Speech at the London Business School
– Hart O and Moore J, 'Default and Renegotiation: A Dynamic Model of Debt*' (1998) 113 The Quarterly Journal of Economics 1
– Heires K, *The Risks and Rewards of Blockchain Technology* (March 1, 2016)
– Holmstrom B, 'Understanding the role of debt in the financial system' (2015) BIS Working Paper No 479
– Inderst R and Mueller HM, 'Informed Lending and Security Design' (2006) 61 The Journal of Finance 2137
– Innes AM, 'The credit theory of money' in Wray LR (ed), *Credit and State Theories of Money: The Contributions of A Mitchell Innes* (Edward Elgar Publishing Limited 2004)
– Innes AM, 'What is money?' in Wray LR (ed), *Credit and State Theories of Money: The Contributions of A Mitchell Innes* (Edward Elgar Publishing Limited 2004)
– Innes RD, 'Limited liability and incentive contracting with ex-ante action choices' (1990) 52 Journal of Economic Theory 45
– International Monetary Fund, *Global Financial Stability Report: The Quest for Lasting Stability*, April 2012
– Jabotinsky HY, 'The Regulation of Cryptocurrencies - between a Currency and a Financial Product' (2018) SSRN
– Judge K, 'Information Gaps and Shadow Banking' (2016) 103 Virginia Law Review (forthcoming)
– Kaldor N, 'The new monetarism' (1970) 97 Lloyds Bank Review 18
– Kirzner IM, 'The Perils of Regulation: A Market-Process Approach , 119–49.' in Kirzner IM (ed), *Discovery and the Capitalist Process* (University of Chicago Press 1985)
– Knapp GF, 'The state theory of money' (1924) History of Economic Thought Books
– Koning J, *Fedcoin* (October 19, 2014)
– Korjus K, *Estonia could offer 'estcoins' to e-residents: The proposal to issue crypto tokens would make the Republic of Estonia the first country with an Initial Coin Offering (ICO)* (2017)
– Kreitner R, 'Legal History of Money' (2012) 8 Annual Review of Law and Social Science 415
– Laurent L, 'The Bitcoin Sovereign Wealth Fund; Estonia wants in on the crypto-currency bubble' *Bloomberg* (<https://www.bloomberg.com/gadfly/articles/2017-08-25/forget-oil-future-sovereign-wealth-funds-run-on-bitcoin?cmpid=socialflow-twitter-business&utm_content=business&utm_campaign=socialflow-organic&utm_source=twitter&utm_medium=social>
– Lehmann M, 'Volcker rule, ring-fencing or separation of bank activities – Comparison of structural reform acts around the world' (2016) 17 Journal of Banking Regulation 176
– Lerner AP, 'Money as a Creature of the State' (1947) 37 The American Economic Review 312
– Levin SA and Lo AW, 'Opinion: A new approach to financial regulation' (2015) 112 Proceedings of the National Academy of Sciences 12543
– Luther W and White L, 'Can bitcoin become a major currency?' (2014) JMU Working Paper in Economics No 14-17
- McLeay M, Radia A and Thomas R, 'Money creation in the modern economy' (2014 Q1) Bank of England Quarterly Bulletin 2014 Q1 14
- McLeay M, Radia A and Thomas R, 'Money in the modern economy: an introduction' (2014 Q1) Bank of England Quarterly Bulletin 2014 Q1 4
- Mehring P, 'The inherent hierarchy of money' (2012) 169 Social Fairness and Economics: economic essays in the spirit of Duncan Foley 394
- Mehring P and others, 'Bagehot was a shadow banker: shadow banking, central banking, and the future of global finance' (2013) Central Banking, and the Future of Global Finance (November 5, 2013)
- Menger K, 'On the Origin of Money' (1892) 2 The Economic Journal 239
- Michel NJ, Fixing the Regulatory Framework for Derivatives, 2016
- Minsky HP, Stabilizing an unstable economy (McGraw-Hill 1986)
- Moore J. B, Horizontalists and verticalists: the macroeconomics of credit money (Cambridge University Press 1988)
- Nabilou H, 'Bank Proprietary Trading and Investment in Private Funds: Is the Volcker Rule a Panacea or Yet Another Maginot Line?' (2017) 32 Banking and Finance Law Review 297
- Nabilou H and Pacces A, 'The Law and Economics of Shadow Banking' in Chiu IH (ed), Research Handbook in Shadow Banking (forthcoming 2017)
- Nachman DC and Noe TH, 'Optimal Design of Securities Under Asymmetric Information' (1994) 7 The Review of Financial Studies 1
- Nakamoto S, Bitcoin: A peer-to-peer electronic cash system (2008)
- Packer F, Stever R and Upper C, 'The covered bond market' (September 2007) BIS Quarterly Review
- Paech P, Shadow banking: legal issues of collateral assets and insolvency law, 2013
- Pennacchi G, 'Narrow banking' (2012) 4 Annual Review of Financial Economics 141
- Poon J and Dryja T, 'The bitcoin lightning network: Scalable off-chain instant payments' (2016)
- Pozsar Z, 'Shadow Banking: The Money View' (2014) Office of Financial Research Working Paper
- Pozsar Z and others, 'Shadow Banking' (2013) 19 Federal Reserve Bank of New York Economic Policy Review 1
- Pozsar Z and Singh M, 'The nonbank-bank nexus and the shadow banking system' (2011) IMF Working Papers 1
- Proctor C, Mann on the Legal aspect of money (7 edn, Oxford University Press 2012)
- Radford RA, 'The Economic Organisation of a P.O.W. Camp' (1945) 12 Economica 189
- Raskin M and Yermack D, Digital Currencies, Decentralized Ledgers, and the Future of Central Banking, 2016
- Reuters Staff, 'ECB’s Draghi rejects Estonia’s virtual currency idea' Reuters (<https://www.reuters.com/article/us-ecb-bitcoin-estonia/ecbs-draghi-rejects-estonias-virtual-currency-idea-idUSKCN1B12B1>
- Ricks M, *The Money Problem: rethinking financial regulation* (University of Chicago Press 2016)
- Rotman S, *Bitcoin Versus Electronic Money* (CGAP Brief, 23 January 2014)
- Rowe N, *Is money a liability?* (2012)
- Rowe N, *From gold standard to CPI standard* (2015)
- Samid G, *Tethered money: managing digital currency transactions* (Academic Press 2015)
- Schnabel I and Shin HS, 'Money and trust: lessons from the 1620s for money in the digital age' (2018) BIS Working Paper No 698
- Schwarz SL, 'The conundrum of covered bonds' (2011) The Business Lawyer 561
- Schwarz SL, 'Ring-fencing' (2013) 87 Southern California Law Review 69
- Schwarz SL, 'Derivatives and collateral: Balancing remedies and systemic risk' (2015) 2015 University of Illinois Law Review 699
- Securities and Exchange Commission, *Report of Investigation Pursuant to Section 21(a) of the Securities Exchange Act of 1934: The DAO, July 25, 2017*
- Selgin G, 'Salvaging Gresham's Law: The Good, the Bad, and the Illegal' (1996) 28 Journal of Money, Credit and Banking 637
- Selgin G, 'Synthetic commodity money' (2015) 17 Journal of Financial Stability 92
- Shin L, *Will This Battle For The Soul Of Bitcoin Destroy It?*? (Oct. 23, 2017)
- Simons HC, *A positive program for laissez faire* (Public Policy Pamphlet No 15, University of Chicago 1934)
- Simons HC, 'Rules versus Authorities in Monetary Policy' (1936) 44 Journal of Political Economy 1
- Sissoko C, 'The legal foundations of financial collapse' (2010) 2 Journal of Financial Economic Policy 5
- Skeel DA and Jackson TH, 'Transaction consistency and the new finance in bankruptcy' (2012) 112 Columbia Law Review 152
- Song J, 'Bits Denomination BIP' (*GitHub*, December 12, 2017) <https://github.com/bitcoin/bips/blob/master/bip-0176.mediawiki> accessed February 09, 2018
- Stark J, *Making Sense of Cryptoeconomics* (August 19, 2017)
- Stenkula M, 'Carl Menger and the network theory of money' (2003) 10 The European Journal of the History of Economic Thought 587
- Stulz RM, 'Should We Fear Derivatives?' (2004) 18 The Journal of Economic Perspectives 173
- Sáinz de Vicuña A, 'An Institutional Theory of Money' in Giovanoli M and Devos D (eds), *International Monetary and Financial Law: The Global Crisis* (Oxford University Press 2010)
- Tapscott D and Tapscott A, *Blockchain Revolution: How the technology behind Bitcoin is changing money, business, and the world* (Penguin Random House LLC 2016)
- Teo EGS, 'Emergence, Growth, and Sustainability of Bitcoin: The Network Economics Perspective' in Chuen DLK (ed), Handbook of Digital Currency: Bitcoin, Innovation, Financial Instruments, and Big Data (Academic Press 2015)
- Townsend RM, 'Optimal contracts and competitive markets with costly state verification' (1979) 21 Journal of Economic Theory 265
- Trautman L, 'Virtual Currencies: Bitcoin & What Now after Liberty Reserve, Silk Road, and Mt. Gox' (2013) 20 Richmond Journal of Law & Technology 1
- Tucker J, Op Ed: Is There a Future for Banking in a Cryptocurrency-Dominated World? (Oct. 11, 2017)
- UK Government Office for Science, Distributed Ledger Technology: beyond block chain, 2016)
- Vardi N, 'Bit by Bit: Assessing the Legal Nature of Virtual Currencies' in Gimigliano G (ed), Bitcoin and Mobile Payments: Constructing a European Union Framework (Palgrave Macmillan UK 2016)
- Vaughan MD and Yeager TJ, "Cedars" deposits: will they fly?" (2003) The Regional Economist 10
- Von Hayek FA, Choice in currency: a way to stop inflation (The Institute of Economic Affairs 1976)
- Weatherford J, The history of money: From Sandstone to Cyberspace (Crown Publishers, Inc. 1997)
- Werner RA, 'Can banks individually create money out of nothing? — The theories and the empirical evidence' (2014) 36 International Review of Financial Analysis 1
- Werner RA, 'How do banks create money, and why can other firms not do the same? An explanation for the coexistence of lending and deposit-taking' (2014) 36 International Review of Financial Analysis 71
- Werner RA, 'A lost century in economics: Three theories of banking and the conclusive evidence' (2016) 46 International Review of Financial Analysis 361
- White LH, Competition and currency: Essays on free banking and money (New York University Press 1989)
- Yermack D, 'Is bitcoin a real currency? An economic appraisal' (2013) NBER Working Paper Series 19747