Distributed Ledgers

Design and Regulation of Financial Infrastructure and Payment Systems

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Notes

Chapter 1

1. See also Mills et al. (2016).

2. Illustrative examples are featured on the IBM Blockchain website. See "Hyperledger Fabric" (https://www.ibm.com/blockchain/hyperledger) and https://mediacenter.ibm.com/media/1_9bo2zfip?mhsrc=ibmsearch_a&mhq=maersk.

3. Chiu and Koeppl (2017) document that more than 740 cryptocurrencies have been introduced as of July 2016.

4. For a stark example of the trade-off between smart contracts on public ledgers and the industry collusion this allows, see Cong and He (2019).

5. According to the Bank for International Settlements (BIS 2018, 91), "Decentralised technology of cryptocurrencies, however sophisticated, is a poor substitute for the solid institutional backing of money." In other words, the cryptocurrencies require independent and accountable central banks. Shin (2018) makes this case based on the economics of user fees for Bitcoin. The fees are high because of deliberately engineered congestion, but that, in turn, limits the use of cryptocurrency as money. Denison, Lee, and Martin (2016) also draw their conclusion: Trustless, expensive decentralized systems such as Bitcoin are not needed, they argue.

6. A related, though opposite, example of slow-moving innovations is a preexisting invention that waits until there is a shock and then the system jumps to a new configuration; see Crouzet, Gupta, and Mezzanotti (2019).

7. Relatedly, the public sector is not limited to reacting to potential and actual private-sector innovations, sometimes with the purpose of preventing them, as with fintechs in some countries, not to mention Bitcoin. The public sector can also take a leading role, as stated in the BIS committee report. An example featuring the Canadian central bank is detailed later in this book. Sweden naturally features its public and private partnerships (PPPs). Sweden's past and present modernization of its payment system provides many salient examples of public innovation—for example, the first issue of paper currency, the highest contemporary user of e-transfers, the recently implemented fast payments system, Swish, and perhaps in the future the first with e-coins (Ingves 2016).

Chapter 3

1. We do not have a natural beginning point, unlike the genesis state in cryptography for the first e-coins, hence we need the measurement of a baseline.

2. For a discussion, see Kestenbaum (2012).

3. See also Bersem, Perotti, and von Thadden (2013) for a related discussion of welfare comparisons.

Chapter 4

1. Ironically, the Swedish Post and Telecom Authority (2017) reports that currency infrastructure is being depleted. Cash is becoming less accessible. Many banks have stopped managing cash with ATMs, which are disappearing. In a growing number of stores around the country, it is not possible to pay with cash today. There is a common worry that people who use only currency may become isolated outside the payment system unless they find the support and help they need. See also Erlandsson and Guibourg (2018). The Riksbank is concerned that without currency, all payment devices in the country are provided by the private sector, which is one reason it is considering a central bank digital currency.

2. See Jack, Suri, and Townsend (2010) for this discussion.

3. See Carlson (2017) for a study of one of them, and more recently Bharadwaj, Jack and Suri (2018).

4. See also Lagos and Wright (2005).

Chapter 5

1. "Those tally sticks met an unfortunate end. The system was finally abolished and replaced by paper ledgers in 1834. To celebrate, it was decided to burn the sticks—six centuries of irreplaceable monetary records—in a coal-fired stove in the House of Lords, rather than letting parliamentary staff take them home for firewood. Burning a cartload or two of tally sticks in a coal-fired stove is a wonderful way to start a raging chimney fire. So it was that the House of Lords, then the House of Commons, and almost the entire Palace of Westminster—a building as old as the tally stick system itself—was burned to the ground" (Harford 2017).

2. This definition comes from Neha Narula in personal correspondence with the author in January 2019.

3. This material is drawn from Ray (2018), Lumenauts.com (2018), and u/PumpkinFeet (2018).

4. See, for example, Athey et al. (2016); Casey et al. (2018); Foley, Karlsen, and Putnins (2019); Griffin and Shams (2018); Prat and Walter (2018); Cong, He, and Li (2018); Cao, Cong, and Yang (2018); Janin, Gervais, and Mamageishvili (2019).

5. See also Dandekar et al. (2012).

Chapter 6

1. See also Green and Oh (1991) and Karaivanov and Townsend (2014).

2. For examples of this second piece, see Abreu, Pearce, and Stacchetti (1990), Green (1987), Phelan and Townsend (1991), and Spear and Srivastava (1987).

3. See Ligon, Thomas, and Worrall (2002) for penalties.

4. See Phelan and Townsend (1991) for an example of how to impose this constraint and what difference it makes for the optimal contract design.

5. See section 10 in Harris and Townsend (1981), and for examples of an implementation literature, see Moore and Repullo (1990) and Palfrey and Srivastava (1989).

6. But see Hart and Moore (2007) for a discussion of incomplete contracts.

7. For a compelling video of how technologies like these can work in practice, see Inveniam Capital Partners (2019) for the context of real-estate transactions.

Chapter 7

1. China has implemented regulation to prevent this kind of delegation to platforms—namely, that platforms be pass-through only. The Chinese government's decision was motivated by incidents of outright fraud.

2. For a generalized treatment of communication in games over time, see Myerson (1986).

3. One clarification, the idea of coloring coins came about as a way to overcome initial limitations in Bitcoin. With the current version of Ethereum, this is no longer needed, but the point about distinguishing histories remains.

Chapter 9

1. Reconciliation and reliable registries were mentioned in the introduction to this book.

2. See Güntzer, Jungnickel, and Leclerc (1998) and Kuussaari (1996) for further discussion of algorithms for clearing and risks.

3. See Monnet and Nellen (2014) for theoretical modeling of central counterparty (CCP) clearing. Also related, see Monetary Authority of Singapore and the Association of Banks in Singapore (2017, 6) on running its own innovation center: "The prototypes successfully demonstrate several points. Firstly, that key functions of a RTGS [real-time gross settlement] system such as fund transfer, queueing mechanism and gridlock resolution can be achieved through different techniques and solution designs. Secondly, decentralizing the key functions of a RTGS system may not only mitigate the inherent risks of a centralized system, such as single point of failure, but may also affirm the promised benefits of DLT, for example cryptographic security and immutability."

4. One vision for Velo has the token as a utility at a fixed price. If there are markets for Velo exchanges against fiat, new issues are raised, and addressed, in chapter 11 on cryptocurrency.

Chapter 10

1. See Townsend (1980), for example, for a more general discussion of why money holding is a distortion and money should bear interest.

Chapter 11

1. Agents may be tempted to make deals on the side, a threat that could reduce multiple currencies to one. However, for there to be an effect, agents would have to hand over their private keys to a third party, and unless this is all in the same family, this type of off-path deviation could be anticipated to be minimal.

2. See also Angeletos, Collard, and Dellas (2016) and Diamond (1965).

3. See also Bryant and Wallace (1984).

4. An exception, Klein (1976), talks of a money to which other monies are tied. Indeed, we can introduce the idea of having multiple-country fiat monies, with value by fiat for example, and think of the dollar standard across currencies.

5. For more on the Tether stable coin, see Morris (2019) and De (2019).

6. For more information, see also Townsend (1989).