Understanding Digital Crime, Trust, and Control in Blockchain Technologies

Full Paper

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Abstract

We review seminal social science theories of Trust & Control to consider how their application to Blockchain and Cryptocurrency (DLT, e.g., Bitcoin, Ethereum, Ripple) provide the potential for fresh criminal and information security challenges to traditional mechanisms of criminal detection and law enforcement. The social science theories of trust and control provide an accessible matrix to evaluate malicious behavior related to these new forms of money and currency. This foreshadows the ability for DLTs to become the 'poison of choice' for crime and security objectives or perhaps be avoided altogether by criminals. We argue that an understanding of DLTs is incomplete without a social science underpinning and framework which trust and control provide. The continued use of these technologies will require public and private institutions to rethink their approaches to crime prevention and information security for purely digital threats.

Keywords

Blockchain; distributed ledger; digital crime; cybercrime, money laundering, ransomware, information systems security, trust, control; Bitcoin; cryptocurrency public policy; money; currency

Introduction

The purpose of this paper is to consider the crime and information security implications from the rapidly evolving technologies which Blockchain and so-called cryptocurrencies (collectively, distributed ledger technologies, or DLTs) with their underlying uses (e.g., Ethereum, Ripple, Hyperledger, Bitcoin) have created. The present research is not a technical sense-making endeavor nor a monetary policy sense-making polemic but is instead a social science sense-making treatise. Elsewhere there are deep technical sources of information to explain DLTs but this paper seeks to put the overall technology in a context of social science literature. For a convenient mental image of DLT, technically, Harvard Business Review recently compared DLT to TCP/IP (Iansiti & Lakhani 2017). We think that is an apt comparison because of the technical umbrella each represent as well as the metaphorical and symbolic comparisons possible between each and society.

Thus, beyond the technical and an implication of the social aspects are the abuse and criminological implications of DLTs. Holt (2017) emphasizes the importance of criminology, and cybercrime in particular, as an interdisciplinary study involving the technical and social sciences. This paper aims to augment the social science theoretical foundation for DLTs generally and cryptocurrency specifically. By establishing a social science underpinning for DLTs, a better grass of their potential for good and ill to society can be gauged and acted upon.

Background

With little fanfare and less pretext, Satoshi Nakamoto's (2008) published specification for Bitcoins has taken first the information technology sector and then – as Bitcoin's underlying ledger system, Blockchain, took on a life of its own – the putative FinTech sector by storm in just a few short years. It is perhaps too soon to put this in perspective but it is unlikely there is an example for non-malicious computer code to have so rapidly captured the attention of the tech world and major industry so rapidly.

Blockchain itself only emerged on its own in mid-2015 after the controversy of Bitcoin's early adoption, use, and abuse settled.

Blockchain more than even Bitcoin in one year's time has spread fast and penetrated deeper 'into' information technology than any computer virus and certainly any previous non-malicious software. It has spawned cottage industries, new variants, and a novel raison d'être for FinTech. Blockchain and the broader usage as DLTs has gained rapid attention and been added to the agenda of national and sub-national governments in all facets, international businesses and public organizations, and most significantly, the international financial sector. Ironically, where Bitcoin is a technology enabled by and for individual users (miners, spenders, savers, speculators) Blockchain's appeal is in the aggregate, among the various organizations and administrative entities which service users. While there is still significant interest among users for Bitcoin and rapidly growing interest from firms for Blockchain, there is also a lack of a theoretical underpinning for what these DLTs represent. Are they merely replacements for antiquated systems or antiquated concepts? Are they better 'mousetraps' than previous mousetraps? Or are there larger more significant reasons for which society should consider and take notice of DLTs?

Problem

We for this research sought to find theories of currency to which DLTs could be mapped and grounded and upon which larger questions renewed by Bitcoin about the nature of fiat currency could be answered. Initially, we were confronted with presumptive theories of money and currency as being evolved economic value technologies (fiat currency, central banking) or so-called 'digital age' aphorisms of peer-to-peer transactions as axiomatically more efficient than 3-party (calling to mind the Theory of the Firm) or that Internet communication enforces more rigorous transparency because of social media and reputation. But none of these withstood scrutiny when cast against broader and ancient economic value systems like barter, hawala, or commodity. Other explanations of economic value discussed below were unsatisfying from a socio-economic sense and failed to fully answer the anthropological and social aspects of economic value exchange which have an ancient history. An initial treatment of the semiotics of Bitcoin as "practical materialism" (Maurer, et al. 2013) was a useful and perhaps the only social science treatment of DLTs to date.

By using the concept of trust in relation to DLTs (The Economist 2015) we pivoted to the deep world of socio-economics. We sought an effective way to explore and further trust's involvement in socio-economic value – we felt trust alone did not 'create' socio-economic value – and which captured common currency types. We could not locate a single theory of money but only a fractured literature about currency systems ranging from anthropology to sociology to GDP and monetary policy. If DLTs are the be-all, end-all of money, a theory about them must account for common money. This should include fiat currencies, Bitcoin's initial target, but also traditional peer-to-peer transactions like barter and commodity/specie currency. Indeed, as well, the classic notions of technologic advances – industrialization, microchip, etc. – need to inform the broader underpinning of DLTs because of DLTs' high-order, applied technologic nature.

Thus what follows is a review of seminal socio-economic theories of Trust & Control which we apply to contemporary currency systems and emerging DLT systems to question their criminological and information security matters.

Extant Social Science & Information Technology Theory

Trust

The Economist in October of 2015 promoted its understanding of Blockchain with a special issue devoted to Blockchain bearing the cover title and art of "The Trust Machine" (The Economist 2015); there are no shortage of references to trust in re Blockchain in recent popular press. Roget's 21st Century Thesaurus lists eleven entendres of Trust, six nouns, five verbs, ranging from: belief in something as true, trustworthy; belief in goodness, realness of something; expectation; confidence; depend upon; putting regard in as true; and, rely on; responsibility, custody; large company; believe, place confidence in; give for safekeeping (trust 2016) – those combine to hundreds of synonyms and that is only in American English. Trust is a classic abstract term which falls under the ever-pragmatic definition of hard to define

but we "know it when [we] see it" (*Jacobellis v. Ohio* 1964) and may well be "the most generally acknowledged [aspects] of social capital" (Tan & Tambyah 2010) however we need a more substantive exploration for this inquiry.

There are numerous social science disciplines which consider trust including philosophy, anthropology, sociology, economics, and psychology. From the perspective of this inquiry, we invoke these disciplines' theories as a basis for a socio-economic theory of trust which captures the relationship between two or more entities engaged in exchange of value. While the DLTs may be themselves cryptographically immutable (capable of trust) this is merely a technological characteristic; getting two parties to trust and be trusted via the medium of DLT is our focus of trust. These two entities can be any combination(s) of individuals and institutions, customers/vendors, or other imagined socio-economic relationships. Any significant understanding of trust hinges on the demarcation between the trusting party and the party worthy of trust – possessing trustworthiness.

Philosophical trust has a history as old as the earliest notions of recorded history in both Western and Eastern traditions. Philosophical trust generally is willing and confident relationships of dependency (Jones 2015). Western philosophers like Aristotle explored trust from the perspective of friendship which could have three reasons, "goodness, pleasure, or profit" (Kraut 2016) and defined the delicate balance of the positive and negative aspects of trust. Trust can be warranted and benefit trusting parties or become unwarranted and disproportionately benefit participating parties over the course of the relationship (McLeod 2015).

Eastern philosophies in the tradition of Confucius "[emphasize] the importance of trust in others, elevating it to one of the eight basic moral principles" (Tan & Tambyah 2010). In some regards, Confucian philosophy may elevate trust beyond Western ideals because Confucian tradition to urge self-reflection when breaches of trust are perceived to have occurred (Koehn 2001), i.e., have you miscalculated your expectations of the counter-party rather than the counter-party failing to meet expectations? A recurring theme then for philosophical trust is that it can iterate and extend unabated in theory and practice; a boundary or boundaries for trust must be established for trust to be useful or valued.

Political notions of trust can be found in the musings of 16th century Machiavelli who nonetheless regarded the establishment of trust as of great political importance operationally by winning "over the affection of the common people" (Spencer 2012). Lockean explorations of trust primarily define trust as a power interplay between the ruler and ruled entailing risk and secondarily about when the ruled may detect an excess in the imbalance and thus a breach of trust (Nacol 2011) and Hobbes, too, created a theory of trust as the interplay between consent of the governed and application of authority from the government (Baumgold 2013).

To be sure these theories of trust are implicit rather than explicit but that is the elusive nature of trust. Furthermore, these definitions of trust are reflexive and lack a mediating force or control. As Locke considered, when can the ruled know a breach of trust has occurred by the ruler and what to do about it then (Nacol 2011)?

Hegel considered trust as a party having a "spiritual witness" to the counter-party "as to its own essence in which it has its feeling of itself [emphasis in original] (Houlgate 2016)." This is highly reflexive and unbound. Perhaps the most succinct understanding of the fuzzy nature of political trust can be found in Ronald Regan's famous perspective of Soviet nuclear disarmament: "Trust, but verify." This, too, implies trust itself can be unbound and needs a controlling force to be of value.

Game Theory

The growing study of behavioral science involving Game Theory and Bounded Rationality captures trust and risk in the Trust Game which covers a range of anthropologic trust scenarios (Gintis 2009). Participants are given a small sum of money to exchange with (an)other participant(s) through mutual judgments of altruism and personal gain (Berg, et al. 1995). This mirrors economic value exchange from prehistoric barter to contemporary social entrepreneurship endeavors. Indeed, recent studies have literally drawn blood to measure oxytocin levels during trust(-ing) (-worthy) actions during the Trust Game (Zak 2017). The elusive nature of an operational definition of trust itself may indicate it doesn't exist and that trust can only be explained in a four-dimensional way invoking socio-economics.

Thus, an additional method of understanding trust is very modern and is through the lens of a socio-economics. Using a basic notion of economics as allocation of (perhaps scarce) resources, one of the main focuses in economics is the so-called Transaction Cost of commerce and this is a locus of trust in economics. Trust in transaction cost can be seen in competition, opportunism, regulation, marketing, branding, risk, uncertainty, loyalty and the business cycle in general. The origins of transaction cost research trace to the Theory of the Firm from Coase (1937) and post-Great Depression retrenchment of society and economic theory. Coase speculated on the size of firms and their attendant imputed overhead to commercial activity for why and how firm size might be accounted. Trust was the pre-eminent mechanism for lower transaction cost. But without control, lower costs become a liability or risk.

Combining transaction cost considerations and behavioral science from above, Bart Nooteboom's (2002) seminal work on trust provides a comprehensive summary of socio-economic trust by focusing on trust as an integral concept which explains (and drives down) transaction cost in all its presences: between individuals, between firms, and among and between individuals and organizations (Nooteboom 2002). Nooteboom rejects the idea that transaction cost could be solely attributed to self-interest (Kahneman's (2003) "economic preferences" or even Adam Smith's (1776) "self-interest" and "Invisible Hand") as it failed to account for altruism among other concepts which more recent political economist have comes to understand permit the smooth functioning of commerce.

But Nooteboom was confounded by unchecked trusted as "unlikely to survive in markets" (Nooteboom 2002). His concern with "blind trust" (ibid.) lacking mediating control is the same as Reagan's political advice above and the philosophers' awareness above of unbound trust disserving the trusting and an abuse by the trusted. Thus, Nooteboom introduces the idea of control or governance and authority to explore how it perfects trust in relationship building. Nooteboom's control mechanisms fall under his broad title of Information and Communication Technology (ICT) and he cites as examples product "search, marketing, and transportation" as evolving over time to increase trust and reduce costs. Chief among these technologies are varying contractual possibilities (communication elements) which capture trusting parties' expectations and provide the means to enumerate and enforce trust in a commercial transaction. Nooteboom presciently invokes (in 2002) the Internet's accelerating ability to provide improved control mechanisms for traditional commercial activities.

Control

The above discussion of trust has invoked bounded aspects of trust which can take the form of controls, governance, or other methods of authority. Nooteboom characterized this controlling mechanism as Information and Communication Technology (ICT) but does so without the apparent use of a significant independent theory about control. As such, introducing attendant social science theories of control will provide significant support for Nooteboom's Trust and ICT specifically and to reinforce this inquiry into currency systems.

Control is an abstract term but less so than the "slippery" (Nooteboom 2002) concept of trust. Control can have negative connotations but many its uses are arguably neuter. In the Trust Game research revealing oxytocin as a neurochemical marker of trust (Zak 2017a), employees report they'd give up 20% of their salary for more control over how their role is executed. This is a stunning link between trust, control and economic value – willingness to give some up. Thus, control has broad applications as being related to administration and influence, and occasionally significantly so; the word alone lacks highly charged non-rational possible uses as trust does. Its humble status as a concept makes it easy to characterize a given type of control. In this case, we can invoke such a theory and encapsulate a broad cross-section of social science with James R. Beniger's (1986) The Control Revolution: Technologic and Economic origins of the Information Society.

Beniger's theory of control is not merely an inquiry into modern civilization's final frontier of control as being beholden to the Information Society, it is a broader theory of control being the essence of the natural world and its evolution and change – humanity included. Beniger threads nature from the broadest possible reference of information processing, "all living systems" (Beniger 1986). He considers the thread of control to have been the impetus for the natural world, to include the origins of life: technologic advances from DNA re-calibrating and information storage in cells, to Homo sapiens and the Stone Age as well as the Enlightenment and Industrial Age. While his theory of control marking the

progression of life by way of information is fascinating, he reserves the revolution and crisis part of his Control Revolution for the 19th century forward.

It is in the 19th century when the rapid change from traditional, natural (haphazard, perhaps) information systems gave way to increasingly ordered and rational information systems. This was evidenced by Max Weber's realization that "the traditionalist attitude….had to be at least partly overcome in the Western World before the further development to the specifically modern type of rational capitalistic economy could take place" (ibid.). And this is related to sociologist Ferdinand Tönnies mid-19th century theories of traditional and intimate relationships (Gemeinschaft) giving way to impersonal and limited (Gesellschaft) relationships (ibid.). This revolution in sociology speaks directly to trust and control where the traditional relationships were highly predicated on trust mechanisms and Beniger's Control Revolution relationships become transactional, thus lacking trust and implying higher transaction costs. Beniger completes his theory by reinforcing the notion of control through information, feedback, and communication to all social systems with an increasing emphasis on the rise of bureaucratic systems, technologic advances, and social structures.

The important contribution of a Theory of Control then for this inquiry into money and currency systems is to demonstrate that the presence of control is part of the natural world and civilization. It is also to demonstrate that as the recent centuries of control have become a crisis and revolution, and inflection point. This is because traditional systems of social order have given way to technologic systems of social order and these technologic systems, as Weber cites, are a "rational capitalistic economy" (Beniger 1986). This new frontier continued relatively well for hundreds of years until the 1970s when international monetary theory began to change (Galbraith 1975).

Trust X Control

With a full accounting of Trust and Control above, seeing their emergence and converging nature we can invoke Nooteboom, et al.'s (2005) research on relationship development which he applied more narrowly than of what we think its true potential is. Nooteboom's seminal 2002 work on trust led him to use in 2005 a 2x2 matrix to measure Trust and Contract Quality between commercial enterprises in his research. The details of that study specifically related to mutual relations between firms and contract length regarding transaction size and costs. The refined matrix, indicated in Nooteboom, et al. (2005), is represented below in Figure 1.

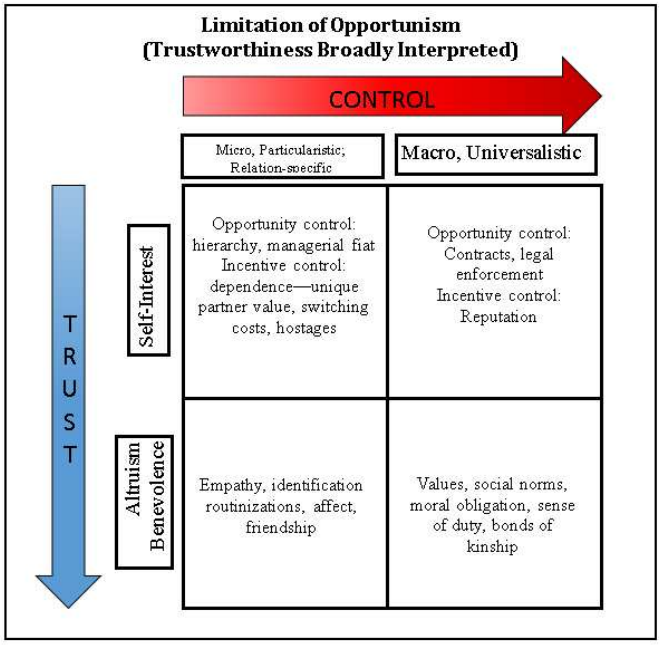

Figure 1 – Nooteboom's Relationship Development Matrix

Nooteboom's matrix and the direction of his pursuit provides a fundamental model to incorporate the exposition of broader sociologic theories above to depict the four major currency systems. Figure 2 below is an extended matrix depicting four main currency systems currency as trust and control. Note the change in terminology of the lower y-axis – External Interest is augmented with Altruism to Sovereignty and can include kinship, community and any other positive interpersonal relations.

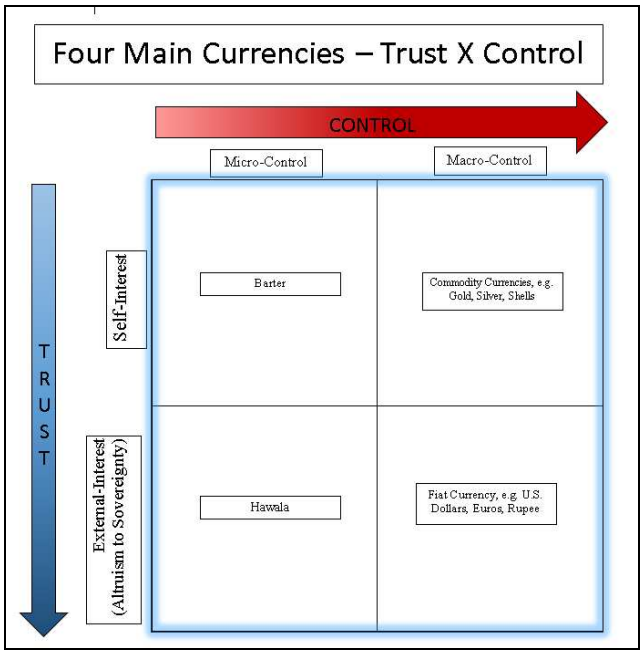

Figure 2 – Trust X Control Matrix with Economic Exchange

This theory of currency as a matrix of Trust and Control allows us to return to our consideration of DLTs. To do so, we further put this theory to use by overlaying DLTs to demonstrate they have an actual socio-economic theoretical underpinning. Figure 3 below depicts where DLTs fit in the matrix:

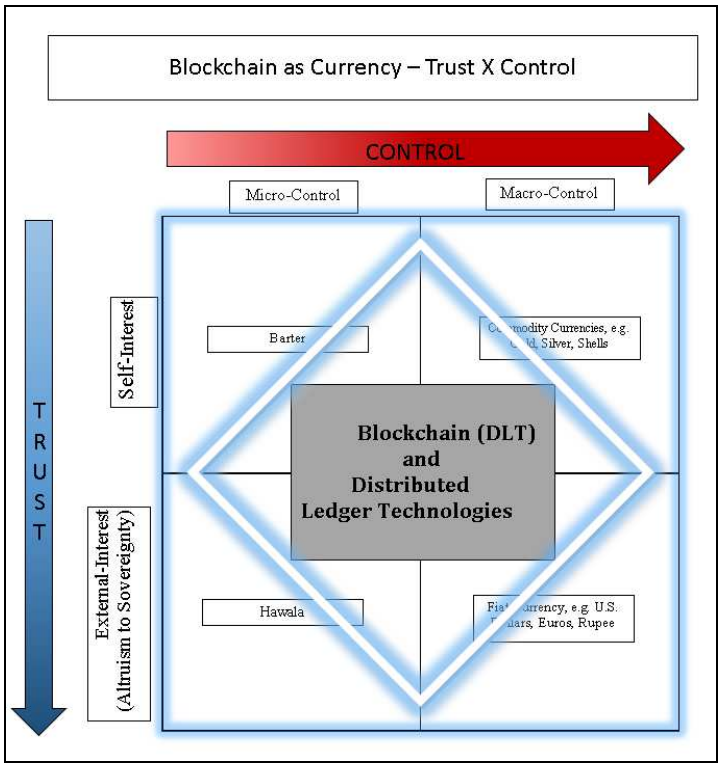

Figure 3 – Trust X Control Matrix with Blockchain Tech. Overlay

The emerging types of DLT which demonstrate arbitrary granularity of Trust and Control from all four quadrants:

1. Bitcoins
    a. Simple peer-to-peer transactions – Barter
    b. Mining and creation thereof – specie or commodity currency features
2. Alt-coins – complementary currency systems (loyalty, community currency systems)
3. Digital currency – replacement and augmentation of national currency system(s)
4. Ripple – broad inter-currency/inter-bank exchange
5. Smart Contracts – contract creation, execution, monitoring
6. Hyperledger – cross-platform blockchain for private sector application

Criminological and Information Security Implications

"The study of cybercrime has been stovepiped for decades" because of the siloed disciplines of academia (Holt, 2017). Within the Information Sciences there are vast differences in the approach computer science takes (algorithms and programmatics) versus information technology (devices, data, access); within social sciences a greater emphasis on the human behavior has predominated (ibid.). Criminology has been more integrative of the two fields, by necessity invoking human behavior and science for hundreds of years (Rogers 2016). But use of behavioral analysis "in cyber criminal investigations has been somewhat limited" (ibid.) and "their increasing prominence in terms of criminality deserves a much wider" embrace in criminology (Brown 2016).

Despite Kevin Mitnick's well-known social engineering breaches in the 1980s, it has been comparatively recently that Information Systems Security has fully embraced doctrines of educating users to prevent socially engineer security breaches. Thus it is becoming ever more clear that technology must be understood in the sociologic context, in particular with regard to criminal and malicious intent. Indeed, if we are to "redress these gaps, then we must begin by identifying commonalities between the fields" (ibid.).

Linking DLTs by way of social sciences like trust and control to more commonly used currency systems is an important step. Understanding exactly what DLTs have in common with Dollars and Yen, et al.

informs the decision processes for promoting the safe and effective use of these new currency systems. However, and more importantly for this paper's ends, when these new currency systems are inevitably used for nefarious and criminal purposes, understanding the social science underpinnings is invaluable. Put simply, to understand that the value of cryptocurrency to a criminal is a question of gradations of trust and control is too better understand why they might use them. Two main examples are ransomware and money-laundering.

Ransomware, a "cyber-hold-up" or "daylight robbery" (The Economist 2015b) is the name given to virus software which spreads and infects likes other malicious software but strong-encrypts the contents of a user's computer (or organization's server/data). The ransomware program explains to the user how much and how to pay to get the files unencrypted. While this has been an option for criminals for years, payments were usually only available via 3rd-party vendors which precluded anonymity for the criminal. The availability of cryptocurrencies – while only pseudo-anonymous – provides a whole new avenue for criminals to broadly use ransomware and escape detection. However, this is not for the reasons one might consider, in fact, "lack of regulation, decentralization, and a high degree of anonymity" have not been linked to Bitcoin being employed as a serious criminal threat (Brown 2016). Indeed, a given cryptocurrency alone may well hold the key (via its pseudo-anonymity) to stopping ransomware as it become more prevalent (Detsch 2016).

A special case of DLTs, cryptocurrency, has potential attraction by criminals is because of the other main example – money laundering – and that is a question of control. The real reason criminals have taken to cryptocurrency is the speed of the payments and processing exchanges to other currencies as well as lower transaction costs (Detsch 2016). This is a trifecta of money-laundering (ML) and something any launderer would recognize as ideal. Substantial and deep trust in the agents of a laundering scheme isn't the prize if the laundering can be fully controlled by the criminal at a lower cost. The "information asymmetry" of a single cryptocurrency (any single currency) but the speed with which a criminal payment can be received as a cryptocurrency and changed to a second or more currency system is very high with cryptocurrency. Thus, the attraction is "an indirect effect on the execution of the ML process, providing positive incentives for money launderers" (Brenig, et al. 2015).

Conclusion

Blockchain and cryptocurrency technologies have emerged with great fanfare but little thorough social science context. As many creations of technology often do, it is not until they are used for unintended purposes that the gap between means and ends is clearest. The use of DLTs in traditional types of criminal activities has tripped that wire. But like social engineering in the Information Security sector or "old-fashioned policework" (Detsch 2016) in the law enforcement sector, the financial instruments which DLTs and cryptocurrencies represent must be contexted in social science to be fully understood and integrated into society.

This paper sought to provide a salient framework of social science underpinning for currency systems which include DLTs and cryptocurrency. By analyzing factors of the sociology of trust and control and their grounding in transaction cost for economic activity we could extend Nooteboom, et al.'s matrix to include typical currency systems in use today. Into this framework DLTs were inserted as a capable overlay to four main monetary systems. In doing so, a clearer understanding of what DLTs represent to society is revealed and applied to criminology. This begins a merger of the technical and social aspects of DLTs which is needed for their border understanding and acceptance as well as for illuminating two emerging criminal use cases: ransomeware and money laundering. With this first step of linking the technical and social aspects of this new technology we hope to contribute to the research in the field of public policy regarding the evolving viability and use of these important technologies.

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