Blockchain Economic Networks and Algorithmic Trust

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Abstract

This research develops a theoretical framework joining sociomateriality practice theories and social capital theories as the basis for a causal model of algorithmic trust in blockchain economic networks. Although there is extensive prior work regarding trust in social networks, collective trust models in the context of risk have not been developed. We argue that algorithmic trust is created as a new form of digital materialized capital using two lines of reasoning. The first is based on the social situatedness and digital nature of blockchain sociomaterial practices (drawing on Orlikowski and Scott 2015; Introna and Hayes 2011). The second develops relational theories of technology in which actors co-produce social reality (Barad 2007), and in which new forms of capital emerge as network resources (using social network trust studies (Sherchan et al. 2013)). We suggest an experimental design using game theory and networked games to evaluate algorithmic trust in credit network liquidity.

Keywords

Blockchain technology, sociomaterial practice theory, algorithmic trust, digital materialized capital.

Introduction: A New Technological Affordance: Algorithmic Trust

A modern societal problem has arisen in that trust has waned in business and governmental institutions. Studies using measures such as the Edelman Trust Barometer found a decline in worldwide trust for the first time in 17 years in all forms of institutions assessed (The Fletcher School 2017, Harrington 2017, and Chakravorti et al. 2018). The solution we examine is the degree to which trust provision is being relocated to technology. We argue that trust is being produced in new kinds of economic network exchange such as blockchain-based transfer. From this situation, we identify a new form of technological affordance or digital materialized social capital, algorithmic trust. Although there is extensive prior work regarding trust in social networks, collective trust models in the context of higher-risk situations such as finance have not been addressed. To fill this research gap, the current proposal develops the compound measure of algorithmic trust. In digital environments, the structure of trust has been shown to depend on two factors, the level of trust that members have with each other, as well as with the service provider (Sherchan et al. 2013). Therefore, the dimensions of trust that we target in our theoretical model development are individual and collective social practices (through the vector of sociomaterial practices theory) and actor co-creation of social reality (through the vector of relational theories of human-technology interaction).

This research has strong practical motivations since although there has been extensive prior work concerning trust in social networks, collective trust models in the context of risk have not been developed. In current literature, trust in social networks has been mostly conceptualized on the basis of individual actors collecting, evaluating, and disseminating trust-related information in a unitary, and often transactional manner, in which there is not substantial risk at stake in actor actions, but rather general social benefits (Sherchan et. al 2013). Thus, it is important to revisit existing theoretical, and more importantly philosophical views toward algorithms as technological affordances for trust. To address this research gap, the current project seeks to articulate a collective trust model in digital networks, in the case of financial risk in blockchain credit networks, as influenced by actor attributes and network structure.
Blockchain distributed ledgers are fundamentally a new way of conducting economic and information transactions using communications networks (Swan 2015, 2017, 2018). Two factors, the real-time transactability of all assets on blockchain systems, and the real-time information climate about network activity (magnitude and type, not specific details) work together to produce a new class of trust which we term algorithmic trust. Algorithmic trust is not merely the computerized instantiation of human trust, but a new concept of trust that emanates from the use of the computational system itself as a replacement for traditional mechanisms of governance, control, and interaction. Algorithmic trust is an information affordance that is a new form of social capital, and is observable as a resource in blockchain networks.

In our theoretical development, we propose a new conceptual model of trust in blockchain networks. We focus on the role of blockchain technology as an algorithmic interface, and how it creates trust in economic exchange, embedded within a social network. We apply a sociomaterial practices and social capital lens. In our model, we seek to articulate the theoretical relationships that explain the dynamics of activity in blockchain economic networks, taking the philosophical view that it is precisely these everyday practices that produce social reality. We develop two lines of conceptual reasoning to support this theoretical view. The first is based on the social situatedness and digital nature of sociomaterial blockchain practices, building on Orlikowski and Scott (2015), and Introna and Hayes (2011). The second is based on relational theories of technology in which actors co-produce reality, developed by Barad (2007), and in which new forms of social capital are instantiated as network resources, drawing on trust studies (Sherchan et al. 2013).

**Blockchain Networks: Socially-situated Materialized Digital Practices**

**Algorithmic Trust is Socially-situated**

The first step we take to theorize algorithmic trust is to adopt a sociomaterial practice theory view to formulate the socially-situated nature of algorithmic trust. This allows us to posit that blockchain network transactions take place in the context of a social situatedness which depends on the relationship of three factors. These are the specific occurrences of situated action, the broader social world in which the actions take place, and the kind of social world that is produced as a result of these practices. Extending Feldman and Orlikowski (2011), we argue that situated actions are constitutive of the production of social life, particularly social life conducted in the context of digital networks. Blockchain-based transactions, undertaken by agents, are important in defining the form of exchange activity in the context of distributed ledgers. Socially-situated technological artifacts highlight the importance of design in sociomaterial practices, and we inform our theory development with Bjørn and Österlund (2014) and Hattinger (2016).

**Algorithmic Trust is instantiated in Digital Practices**

From the theoretical basis of formulating algorithmic trust as being socially situated and invoked in the materialized production of social structures and agent activity, the second theorizing step we take is to define algorithmic trust as it is related to digital practices. Prior work in the area of digital practice theory supports the position that digital services and their implications become materialized in practice. Introna and Hayes (2011) study the interaction of human and technical actors (in a plagiarism detection system). They highlight the constitutive effects of practices in shaping identities, and also the unintended consequences. Orlikowski and Scott (2015) develop the argument that digital service innovations (such as web-based crowdsourced ratings) should be seen as being materialized through practice. We build on this view to conceive internet-based services, specifically blockchain-based financial services, as digital services that are materialized in the course of use. The implication of digital practices conceived with the full weight of sociomaterial practice theory is that this line of reasoning might likewise apply to blockchain practices.

**Blockchain networks are Relational**

Having established blockchain economic networks as socially-situated materialized digital practices, we now turn to the other arm of our theoretical model development to posit that blockchain networks are relational. There is a substantial research lineage which considers a relational approach to technology. Some of these approaches include actor-network theory (Callon 1986; Latour 2005), Knorr-Cetina’s (1997) object-centered sociality, and Latham and Sassen’s digital formation (2005), as expounded by Orlikowski and Scott (2015). More recently, theorists have begun to consider information systems as a specific kind of
technology with sociomaterial effects (Mol 2002; Suchman 2007). Specific to algorithms, Galloway notes the rise of “algorithmic culture” (2006), Lash considers “algorithmic power” (2007), and Zysman discusses algorithmic services facilitated by Information Technology tools (2006, 48).

We draw upon the relational technology arguments developed in this prior work to articulate the conceptual shift that we think is a precondition for transacting in blockchain networks. The sociomaterial relational lens allows us to formulate a frame for how agents may be conceiving the network activity in which they are participating. It is different for an actor to engage in a digital network activity than to conduct a physical-world activity such as a face-to-face transaction. Our model posits that the actor’s practices conceptualization is fundamentally different, not just in a digital environment, but in a digital network environment. The digital network environment does not merely replicate the one-to-one exchange functionality of the physical world, but rather creates a structurally different, multi-partied, always-on exchange environment that is conceptually distinct, and derived through participation.

**Generative Concept of Network Co-participation and Intra-action**

To characterize a digital network-based conceptualization of market exchange, there are two components, first a network conceptualization of actor sociomaterial practices, and second, the precondition for acting on the network, which is algorithmic trust. Barad (2007) provides the expansive recharacterization of activity that we seek for defining the conceptualization of participating in a network. Barad describes a practices constitution of emergence which delineates actor conceptualization of the domain of network environments. For Barad, agential realism is the co-constitution of social reality through the intra-action of agents. *Intra-action* and *interaction* are different in that inter means among or across and intra means from within. For Barad, when parties *intra-act* they do so in co-constitutive ways; individuals materialize through intra-actions, and the ability to act emerges from within the relationship, not outside it. The relational connection between parties enables the co-creation of social reality. The reason that this is important is because intra-action provides a generative and a participant-formed practices mode of creating social reality. We argue that intra-action invokes the generative sense of actor conceptualizations regarding the use of digital networks for exchange. Digital networks encompass not only the underlying network technology, but also the intra-actions they imply among human and non-human actors. Blockchains are a network phenomenon that is constituted through intra-actions between humans, practices, and technology.

**Algorithmic Trust as New Form of Digital Materialized Capital**

In our theoretical model development, Barad’s notion of agential realism captures the generative actor conceptualization of what it is to produce social reality by co-constitutively engaging in network intra-actions. The condition for this intra-action is algorithmic trust qua computational trust in the network domain. To specify algorithmic trust, we build on extensive prior research regarding trust in social networks from Sherchan et al. (2013), and define algorithmic trust more specifically as an information affordance that renders social capital, the resources in social networks, observable. Algorithmic trust has been identified as a crucial aspect of digital financial transactions (in the context of online banking (Suh and Han, 2002)). Also, related components of trust such as cooperative tendency have been noted as a form of social capital (Huang, 2007). This grounds our theory that algorithmic trust is a new form of digital materialized capital in social networks, particularly in the context of financial transactions. The link between trust and transparency has been noted as an important credibility feature in social networks, which is also linked to social roles (Matei et al. 2015), but has not been investigated in higher-risk domains such as the financial transaction context, where we believe it will be crucial.

With these underpinnings, we conceptualize *algorithmic trust* as a compound measure that joins social capital (trust) and market activity (information), which together are conveyed by algorithmic interfaces. Algorithmic interfaces, and the transparency they create, algorithmic transparency, is a known construct that is used otherwise in network theory. It generally refers to openness about the purpose, structure and underlying actions of the algorithms used to search for, process, and deliver information. In our theoretical framework, we extend this definition to mean algorithmic transparency as an abstract level of network resources (social capital and market activity). We think that algorithmic trust is a form of social capital provided by algorithmic interfaces, and even more so by their being transparent. In blockchain networks, algorithmic transparency corresponds to the unique affordance of simultaneous transparency (of aggregate network activity) and privacy (of user-specific transaction details). We merge these elements of
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transparency, information, and social capital to define algorithmic trust as a factor which impacts credit availability in digital financial networks and constitutes a new form of digital materialized capital.

Implications for Experimental Research

The sociomaterial practices lens that underlies our theoretical model stresses the importance of analyzing activity at the level of everyday practices. Therefore, the experimental design setting for this project has a mixed-method approach which combines the network modeling of transaction data from an existing blockchain network with controlled behavioral experiments. There are two phases planned for the behavioral experiments, first testing our hypothesis that a credit network with algorithmic trust may reach a Nash equilibrium state more quickly, and second testing a wider range of social factors not captured with the game theoretic approach. We use a design theorizing approach to develop the representation of the real-time information climate in the network following Baskerville and Vaishnavi (2016). The Nash equilibrium experimental model draws from Jackson’s network game theory analysis (2008), Crawford’s dynamic games (1985), and Migheli’s game theoretic experimental results for assessing trust through social capital (2012). The social networks experimental model is inspired by Mason and Watts (2012, 2016), Boyle and Shapira (2011), and Lazer and Friedman (2007), using previously developed visualizations (Brunswicker et al. 2017), and also builds on Kızılce’s (2016) algorithmic interface transparency testing.

Conclusion

This paper develops a theoretical model based on sociomaterial practice theories and social capital theories to define a new construct, algorithmic trust, in the context of blockchain economic networks. Two properties that crucially define blockchain networks, the real-time transactability of assets on blockchain systems, and the real-time information climate about network activity, together produce a new class of digital materialized trust which we term algorithmic trust. Algorithmic trust is an information affordance that is observable as a resource in blockchain networks. The potential benefit of this work is quantifying the value of algorithmically-derived trust in blockchain economic networks. Trust is the benefit of diminished risk, where financial risk savings have been calculated in the form of decreased operating costs (85%) and reduced capital requirements (15%) (BCG 2012, 10). A related study regarding the Ripple cryptographic network notes that 50% of the 29 million transactions as of August 2017 were credit trustlines left open on the network, indicating another measure of algorithmic trust (Moreno-Sanchez et al. 2018, 3).

We argue that algorithmic trust is created as a necessary network resource in order for transactions to be executed in the absence of traditional forms of financial control. We develop a theoretical model in two vectors. First, we establish blockchain economic networks as socially-situated materialized digital practices. Second, we extend relational models of technology to posit a generative concept of network participation and actor co-production of social reality. Within the concept of network co-creation, we substantiate algorithmic trust as a new form of digital materialized capital that is visible as a network resource. We conclude by sketching an experimental approach using network modeling, and game theoretic and networked games to test the structure and measure the value of algorithmic trust as a network resource.

REFERENCES


