Capitalism after Satoshi: Blockchains, dehierarchicalisation, innovation policy, and the regulatory state

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Abstract: What are the long-run economic and policy consequences of wide-spread blockchain technology adoption? We examine the structural economic effects of this institutional innovation as *disintermediation* in markets, *dehierarchicalisation* of organisations, and growing private provision of economic *infrastructure* for exchange, contracting and coordination. We predict that these institutional economic dynamics undercut the historical rationale for much modern economic policy, originally formulated to enable capitalism to cope with market power, to control hierarchy, and to furnish public infrastructure for trust. We argue that capitalism built on distributed ledger technology requires different economic policy settings to industrial capitalism, based on centralised ledger technology. We formulate the institutional logic of this dynamic co-evolutionary model, and discuss policy settings for an economy coordinated with blockchain infrastructure and associated distributed digital technologies for economic coordination (Web3, Industry 4.0). We find that much modern economic policy will be differently instantiated (e.g. hard-coded in platforms) or variously no longer necessary (because of new institutional solutions to problems of trust and coordination). We argue that the institutional innovation of blockchain engenders a new post-industrial economic era that requires new policy rules. This paper seeks to explain why this change will occur, and to explore a new framework for economic policy adapted to economic infrastructure built on distributed ledgers.

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1. Introduction

Ten years after Satoshi Nakamoto released the Bitcoin White Paper, and invented the blockchain, we are now beginning to understand the consequences of this innovation.[1] We argue that the consequences of Satoshi's vision extend well beyond a transformation of the technology of private money and payments, or even of bootstrapped digital value platforms based on smart contracts and distributed autonomous organisations (DAOs) (Swan, 2015; Catalini and Gans, 2018; Vigna and Casey, 2018; de Filippi and Wright, 2018; Van Rijmenan and Ryan, 2018; Werbach, 2018) but, more broadly, to a fundamental transformation of the economic institutions of capitalism.

Capitalism works differently after Satoshi. This paper seeks to explain why that is so; through a descriptive endogenous model of the governance of technology and economic growth. Our core insight is that trust is the foundational resource of any economy, and institutions that can engender trust facilitate extensive economic cooperation and therefore value creation.

Markets are well-understood drivers of economic value, but they rely on the trust embodied in organisations (firms) and are supported by government institutions that provide money, and enforce property rights and the rule of law. Economists since Adam Smith have long understood that high-quality institutions are the primary drivers of economic growth and wealth (North, 1990).

Trust is an input into economic cooperation and in economic theory has usually been understood as being exogenously provided. Institutions, however, are social technologies; technological evolution does not just affect recipes for new production processes but also affects social organisation. Blockchain is an institutional technology that lowers the cost of trust (Davidson, de Filippi and Potts, 2018; Davidson, Novak and Potts, 2018). Blockchain endogenises the manufacture of trust. Economic activity organised on blockchains (better described as decentralised ledger technology) will potentially have lower transaction costs than those transactions organised using centralised ledgers. This, we suggest, will result in institutional competition and evolution. This is how capitalism works differently after Satoshi.

In the first part of this paper we use institutional economic analysis to predict the long-run economic and policy consequences of wide-spread adoption of blockchain technology. We identify blockchain as an institutional technology (Davidson *et al*., 2018), meaning that we analyse its economic effect using the language of transactions costs (as an institutional innovation) *not* production costs. Blockchain technology affects the transaction costs of economic coordination, not just the production cost of

[1] We refer to this as Satoshi's vision rather than Nakamoto's vision following the naming convention of the fundamental unit of a bitcoin as a Satoshi, not as a Nakamoto. It is still unknown as at the time of writing (Nov 2018) who, or whom, are the author(s) of the Bitcoin whitepaper.

specific economic activity. It therefore disrupts entire economies of interlinked production and consumption. These first-order structural economic consequences of blockchain (and distributed ledger technology more broadly) are, we predict: *disintermediation* effects in markets; *dehierarchicalisation* effects on organisations; and substitution from the public provision of *institutional infrastructure* for the manufacture of trust (e.g. identity and asset registries, value transfer platforms, and monitoring, arbitration and regulatory functions) toward private or club provision of that infrastructure..

Blockchain technology provides the institutional foundations for a capitalist economy in which the basic economic infrastructure of counterparty identity management, money and payments, property rights registration, transfer and settlement, commercial contracting, arbitration and dispute resolution, and exchange and regulation are built into blockchain trading platforms. Economic theory already describes such decentralised economies (Mises, 1949). Our question is what sort of policy does such an economy require, and how does it differ from extant policy settings? Our answer is that the differences are profound and the economy will require new regulatory and policy settings.

We examine how these first-order structural economic effects (disintermediation, dehierarchicalisation, and private infrastructure) will have second-order consequences for economic policy—especially competition, innovation, and industry policy. The origin for much modern economic policy is an adaptive and counterbalancing response to the market and organisational externalities of industrial capitalism. If those externalities are alleviated or even removed, then so too is the policy rationale. Blockchain adoption is beginning of a process of entrepreneurially unwinding layers of accumulated market intermediation and organisational hierarchy. It is laying down new economic infrastructure. This insight predicts reduced demand for economic policy to readdress the negative consequences of industrial capitalism in the specific context of macroeconomic policy, competition policy, industrial regulation, and industry and innovation policy. The upshot is that much economic policy, as formulated in response to the specific institutional dynamics of industrial capitalism, will be undercut by the entrepreneurial application of blockchain technology.

Blockchain technology has the potential to provide new economic infrastructure for a property rights based and institutional rule governed economy. It is the central prediction of institutional cryptoeconomics that capitalism, after Satoshi, will be flatter, more decentralised, distributed and polycentric, and have less centralised governmental control. It will be governed more by private orders (Hayek, 1960; Leeson, 2011; Stringham, 2015), or by clubs or commons in the form of platforms (Ostrom, 1990; Aligica and Tarko 2012, Frischmann, Madison and Strandberg, 2014; Potts 2019) than by public orders at the level of the nation state. The question we seek to address is how this effects the supply and demand for economic policy?

2. A model of the evolution of capitalism

Karl Marx (1907) gave the name "Capitalism" to the economic system characterised by private property rights and market exchange, under the rule of law. Marx meant it as a scientific description of its fundamental factor, capital, and its dynamic concentration into entrepreneurial purpose. Marx was concerned with the social dynamics of the accumulation of capital, and he thought capitalism could be altered by political or social revolution. What Marx did not foresee was that the institutional features of capitalism can also be altered by a technological revolution. We argue, in 2009 that technological revolution occurred. Capitalism has been disrupted, not by a revolution that changes the bargaining power of coordinated factors of production, but rather by a technological revolution that provides greater access to the means of production and expands open access opportunities to trade and create value.

To be clear, capitalism is not an institution that protects and valorises a particular social class (capital owners), but rather an institutional system that creates and reinforces property rights and therefore enables exchange and economic coordination in whatever is "capital". These days specific human capital is often far more valuable than generic physical capital. Tomorrow algorithmic capital may be more valuable still. The locus of economic value continually shifts, and capitalism is the name given to an institutional system that can coordinate and govern these transactions. Blockchain technology has been welcomed and embraced by philosophical supporters of platform cooperativism or other economic models of citizen commons, sometimes called the sharing economy (Benkler, 2006; Allen and Berg, 2014), and with good reason.

We want to distinguish between a pre-blockchain era of global market capitalism, and the post-blockchain era, which we are now entering. Our theory is that blockchain technology will disrupt the coevolution between waves of industrial technology, organisational hierarchy to exploit these innovations, and policy to control the organisations. This is because blockchain is an institutional, or governance, technology (Davidson *et al*., 2018) that inserts itself into this coevolutionary process by disrupting the formation of hierarchy in consequence of industrial innovation, and thus mitigating the need for policy to control hierarchy, as well as for corrective policy to restore the dampening effect of market regulation on innovation.

We set out this co-evolutionary model in two distinct phases. The first we associate with the classical dynamic economic analysis of Smith, Marx, and Schumpeter. The second we associate with economic policy formation through the 20th century, which itself comes in two distinct waves: Pigou-Keynes (market and industry policy, characteristic of the first half of the 20th century) and Nelson-Arrow (systems and innovation policy, characteristic of the second half). Our historical model appears in

Table 1. near here]

Table 1 A historical dynamic of the supply and demand for policy

Step	Observation	Structural dynamic	Phase
1	New technologies (machines) cause economic growth	Division of labour and innovative discovery (Smith 1776)	Phase 1: Classical dynamic economics from Smith to Marx and Schumpeter
2	Economic growth fosters *economic complexity* (which in turn fosters more economic growth)	Economic evolution (Marx 1867-1883; Schumpeter 1942)	
3	Available (governance) technologies means that this complexity has to be governed *hierarchically* – in hierarchically organised firms and governments	The critique of power in a complex market economy (Marx 1867-1883; Schumpeter 1942)	
4	The costs of hierarchy induces demand for *policy responses* to reduce those costs	Progressive interventionism (Pigou 1920; Keynes 1936)	Phase 2: Economic policy response from Pigou-Keynes to Nelson-Arrow
5	Policy responses to hierarchy reduce *innovation*	The Hayekian critique of innovation policy (Hayek 1945; Wegner 1997)	
6	Reduced innovation induces demand for *innovation policy* to compensate	Classical innovation policy (Nelson 1959; Arrow 1962)	

Market capitalism emerged from the *Ancien Régime* as cultural and economic institutions emerged to facilitate trade and commerce (Mokyr, 2016; McCloskey, 2016). This happened slowly but inevitably, as these new institutional technologies of governance begat the industrial revolution (Mokyr, 2009; Potts 2019), with the entrepreneurial discovery of new sources of power (coal and steam) and materials (steel) and new economic models, such as the organisation of capital and labour in factories for new industries (textiles). Trade in markets begets specialisation begets the growth of knowledge. For Adam Smith, who wrote when such industrialisation was barely visible, the wealth of nations is limited only by the extent of the market.

As global markets grew and the factory system and industrialisation unfolded through the 19th century, the consequences of capital investment and accumulation to achieve organisationally efficient scale began to create problems of monopoly in markets and the asymmetric bargaining consequences among factors of production. The Marx-Schumpeter thesis maps the relationship between innovation, complexity, and hierarchy. The Smithian division of labour under capitalism drives innovation and complexity, which in turn induces hierarchical forms of governance. Capitalism, as Adam Smith (1776) explained, emerged from the collapse of the *Ancien Regime* and its feudal policy order of mercantilism, guild-based protectionism and other such constraints on trade and innovation. Smith saw complexity as deriving from two sources: the division of labour, and technological improvement. In a draft of the Wealth of Nations, Smith was clear about how the former fed the latter. "When the whole force of the mind is directed to one particular object, as in consequence of the division of labour it must be, the mind is more likely to discover the easiest methods of attaining that object than when its attention is dissipated among a great variety of things" (Smith, 1978, pp. 568-569). Capitalism expanded and globalised as new industrial technologies and entrepreneurial growth in a market economy drove increased economic complexity in a process that unfolded through the 18th and 19th centuries. This was the capitalism that Marx critiqued and that the various socialist and communist revolutions sought to overthrow.

Karl Marx (and Joseph Schumpeter after him) analysed, and predicted, the rise of hierarchy as an outgrowth of industrial innovation. Complexity induced the formation, through entrepreneurial supply, of large hierarchic organisations to amass capital, creating monopolistic competition. In the Marxian model, capital naturally accumulates monopolistically, as small firms displace larger firms. Joint stock companies allow capitalists to combine resources and outcompete smaller companies. The declining rate of profit is partially compensated by product innovation. The growth of hierarchy – what Marx calls 'centralisation' – provides economies of scale and "the progressive transformation of isolated processes of production carried on in accustomed ways into socially combined and scientifically managed processes of production" (Marx, 1907, p. 688). In this sense hierarchy was both the result of innovation (the tendency towards monopoly caused by accumulation and the joint stock company) and complexity the result of hierarchy, as hierarchies are able to combine resources and coordinate around large projects (such as railroads). Schumpeter adopts many of the key elements of Marx's model (Elliott, 1980).

Marx also did not foresee that capitalism would evolve in consequence of his critique, and the socio-political movements it spawned. There emerged through the late-19th and mid-20th century a series of policy responses associated with controlling monopoly (what we now call competition policy and market regulation) and the creation of redistributive social insurance (the welfare state) to tame the disruptive consequences of capitalism.

These institutional adaptations are now broadly embedded within the "grand bargain" of modern capitalism and democracy. But the price these adaptations has been to weaken entrepreneurial incentives and raise costs to innovation. Joseph Schumpeter (1942) worried this bargain would slow and possibly stop the dynamic impulse of capitalism. In response, the second half of the 20th-Century saw further institutional adaptation to engender sectoral and macro innovation through a grand government-corporate complex variously called industry or innovation policy (Bush, 1945; Nelson, 1959; Arrow, 1962).

The dynamics of industrial capitalism is a story of creative destruction in markets and firms and as an evolutionary history of industrial trajectories of general-purpose technologies in steam, steel, railways, oil and chemicals, electricity, plastics, computers, and so on (Schumpeter, 1939; Perez, 2002). But the long-run dynamics of capitalism can also be seen from a deeper institutional perspective of evolutionary political economy, as policy frameworks have emerged and responded to these forces of industrial dynamics. In our model, steps (4)-(6) are cyclical, as the consequences of one policy intervention spark further policy interventions. Over time these interventions build up – one survey of the United States' Federal Register is titled *10,000 Commandments* (Crews, 2018) – with consequences for economic dynamism and innovation (Wegner, 1997; Berg, 2009). Here we can see how economic complexity leads to policy complexity, or what Teles (2013) called *kludgeocracy*, the accumulation and incoherence of sporadic interventionism. Our contribution is to understand the endogenous drivers for that "kludge". What is now called the "mixed economy" is the result of a dual governance approach that initially trusted the governance of new technologies to hierarchical firms, and then once the consequences of that governance system were made apparent, superimposed regulation and interventionism on top. The result is what Wagner (2014) called "entangled political economy", where public and private entities comingle, and economic outcomes are the result of the complex interactions between multiple institutional sets (see Allan, Berg and Novak, 2018 for an application to the blockchain space).

3. Blockchain as a technology of dehierachicalisation

Blockchain is a *new institutional technology* that disrupts not only services and industries, but also old institutional technologies such as the organisation and governance of firms, markets, networks and governments (Davidson *et al*., 2018). We present the basic economic theory of blockchain using a hybrid of: transaction cost economics (in the manner of Coase-Williamson-Ostrom); information economics (viz. Arrow-Spence); organisational and governance economics (viz. Hart-Shleifer); and evolutionary economics (viz. Schumpeter-Hayek-Nelson). The core argument of what we call *institutional cryptoeconomics* (Berg *et al*., 2019) is that blockchain changes the costs and benefits of different forms of economic organisation through the effect of a new institutional technology for transactions.

The basic first-order prediction is that blockchain technology causes or induces *disintermediation* toward a more decentralised peer-to-peer transactional network, as well as *dehierarchicalisation* as the information benefits of organisational hierarchy are weakened through competitive substitution.

La Porta *et al.* (1997) define trust as 'a propensity of people in a society to cooperate to produce socially efficient outcomes and to avoid inefficient noncooperative traps'. Their argument is that trust becomes more important when individuals interact less frequently as reputation for cooperative behaviour is less valuable. As such trust as a civic value is important in sustaining transactions on the open market. It is also important in sustaining cooperative behaviour in large organisations (be they either private or public). They are able to produce empirical evidence that supports the notion that *ceteris paribus* higher levels of trust are associated with a larger share of large corporations within an economy. It appears from the La Porta (1997) analysis that trust is a 'good thing'.

The challenge, however, is that trust is expensive to maintain. Davidson, Novak and Potts (2018), for example, estimate that 35% of US employment is given over to the maintenance of trust. These cost-of-trust employment occupations include managers, lawyers, accountants, auditors and the like. Like reputation, trust takes a long time to develop, is expense to maintain, and can be easily lost. It is here that the blockchain plays an important role. Berg, Davidson and Potts (2019) argue that the blockchain operates as a three-sided market. It operates as a platform to facilitate trade between willing buyers and sellers. It simultaneously creates an incentive system for third parties to monitor, record, and validate those transactions. This mitigates against the need for the initial two transacting parties to trust each other, or to undertake either monitoring or bonding costs to establish trust between themselves.

Williamson (1985) argues that opportunism (self-interest seeking with guile) plays a major role in determining organization form.[2] This is the notion that counter-parties to transactions cannot be (ordinarily) trusted and so expensive efforts must be made to secure those transactions. Investing in building trust is one such effort. In a market environment where opportunism is absent individuals can engage in transactions on the basis of promising to behave well. To constrain opportunism (at some cost) in order to transact, it is necessary to engage in some form of governance structure (such as the modern corporation for example). Spot market transactions can occur in the presence of opportunism, but only in the absence of (what Williamson describes as) asset specificity (organisational specific sunk costs).

For our purposes it is also useful to note that La Porta *et al*. (1997) suggest that trust may not be 'truly exogenous' – that trust may be habit forming. Specifically, that trust evolves over time within horizontal networks of association. The modern corporation, however, is not a horizontal network, it is most often

[2] He also includes other factors such as asset specificity and bounded rationality. Here we wish to focus on trust and opportunism.

a vertical network. This suggests that trust may be particularly expensive to maintain in the modern corporation.

In a 1974 article Harvard professor (and Marxist) Stephen Marglin addressed the question "what do bosses do?". Marglin (1974) askes two questions in providing his answer. First why have "actual" producers "lost control of production"? Being a Marxist, Marglin's answer to this question revolves around exploitation theory and expropriation of surplus value. His second question is far more interesting – "What circumstances gave rise to the boss-worker pyramid that characterizes capitalist production? And what social function does the capitalist hierarchy serve?" In short, Marglin's answer to his second question is that hierarchy serves no social function and is a mechanism to facilitate exploitation. To paraphrase Coase (1972) when a Marxist sees something he doesn't understand he invokes exploitation – Coase had originally opined that neoclassical economists see monopoly if they cannot understand social phenomena.

Marglin's argument rests on three legs. First, he argues, quite correctly, that mainstream neoclassical theory cannot and does not explain the existence of hierarchy. As Jensen (1983) explains mainstream economic theory does not have a theory of the firm, it was a series of cost curves that serves more as a theory of markets. Ironically Marglin knows of Coase (1937) and quotes it extensively in a footnote (46), yet the importance and insight associated with Coase (1937) appears to have escaped Marglin. As Coase (1972) himself ruminated, his 1937 paper was more cited than actually read – or in this instance cited and read, but not really understood. Marglin's second leg is an historical analysis of the emergence of the factory system during the industrial revolution. Here his interpretation has been challenged and critiqued by economic historian David Landes (1986).

For our purposes it is the third leg of Marglin's argument that is of interest. He was underwhelmed by Adam Smith's pin factory example – see generally Landes' (1986) critique. Marglin makes several points that are entirely correct: neither hierarchy nor the division of labour were invented by capitalists. What changed under capitalism, Marglin argues, was that previously "the man at the top was, like the man at the bottom, a producer". Second, that hierarchy was linear not pyramidal and third, that workers sold a product and not their labour. Marglin also correctly identifies the social function of the modern corporation – it mediates between producers (Marglin means workers), shareholders, and the market. The notion that the modern corporation constitutes a nexus of contracts is now well-known and understood (Jensen, 1983). Marglin also correctly identifies that "without specialization, the capitalist [Marglin here means "boss"] had no essential role to play in the production process". It is here that Marglin misses the Coasean (1937) insight. Despite being a Marxist, Marglin operates in a theoretical world of zero information and transactions costs.

He points to Adam Smith's argument that specialization depends upon the size of the market, but then quibbles about the meaning of the consequences of specialization. He seems to have completely missed

the fact that market size did increase during the industrial revolution. Advances in communications, reductions in transport costs, and the ability to deploy mechanised energy (as opposed to animal or human energy) were technological advances that increased the size of markets and dramatically reduced production costs. It is at this point that greater specialization becomes profitable, and hierarchy emerges as a further specialization to economise on the transaction and information costs generated by the need for greater cooperation under the division of labour.

It is entirely correct that social hierarchy and military hierarchy long pre-date economic hierarchy. What is telling, however, is that economic hierarchy only emerges when it is profitable to do so. The emergence of hierarchy – or "governance structures" as Oliver Williamson (1975, 1985) describes them – is well explained by the economic historian Alfred Chandler (1962, 1977). Similarly, Alchian and Demsetz (1972) have analysed the challenges of team production. Specialised pin manufacturers cannot renegotiate contacts in real time with other specialised pin manufacturers due to the existence of asset specificity, opportunism, and Coasean transaction costs (see Williamson, 1985) but rather must engage in team work. Team work, however, may resolve general Coasean transactions costs and asset specificity, it may not resolve opportunism costs. To resolve those costs, Alchian and Demsetz hypothesise the emergence of a specialist managerial function that monitors team production to avoid shirking and ensure the profitable and productive use of joint resources.

4. The political-economic consequences of blockchain

We predict the effect of blockchain adoption will reduce demand for economic policy. This is the sense in which blockchain (and related institutional technologies) marks the beginning of a new era of capitalism that will require a reconceptualized role for both management and economic policy. A trustless technology such as blockchain will expand the role of markets (horizontal networks) and contract the role of hierarchy (vertical networks). In the historical dynamic in

Table 1, blockchains disrupt step (3), providing for a new model for governing complexity as an alternative to hierarchy. Governance is a variable that is sensitive to prevailing institutional technologies, and new approaches to governance materially change the demand for public policy through steps (4) - (6). Complexity can be governed through non-hierarchical institutional forms. The demand for policy shifts accordingly.

The logic of this prediction flows from Williamson (1985). In the presence of lower information and transactions costs the number of profitable spot market transactions increase. Similarly, in the presence of lower information and transactions costs the governance structure itself becomes more profitable too but at the same time the governance structure will now also be at comparative disadvantage to promise-to-behave as an organizational principle. Hierarchy that exists simply to supress opportunism will now

be less profitable compared to organizational alternatives. Institutional economics predicts that the adoption of blockchain technology will increase economic activity coordinated through markets and reduce demand for hierarchic organisation, including firms and government. Many sectors of the economy will be disrupted by this growth of markets and networks, with new types of market forms emerging, such as data markets, and more direct P2P exchanges for newly "tokenised" assets and services.

These first-order Coasean effects of disintermediation are an obvious general prediction of the structural consequences of widespread adoption of blockchain technology. A further first-order "Ostrom" effect is growth of the so-called "sharing economy" through civil-society-based provision of services and value owing to the lowered costs of community governance technology through smart contracts, DAOs and other blockchain-enabled institutional governance technology relying on the "order of code", or *Lex Cryptographia* (De Filippi and Wright, 2018). Blockchain adoption will increase the scale of economic activity coordinated through trusted promises (i.e. smart contracts) and markets, which will create a more polycentric economic order (Aligica and Tarko 2012), and decrease the relative scale of activity coordinated through firms and governments. This will unfold as a process of disintermediation and dehierarchicalisation.

We can already see a flourishing in new structures of corporate organisation as a result of disintermediation and dehierachicalisation. Distributed ledgers allow for information about supply and production chains to be shared between multiple accounting entities. Exploiting this characteristic, the "V-form organisation" has emerged, first in the global supply chain and logistics industry, in which vertical integration is virtually outsourced to a blockchain (Berg, Davidson and Potts, 2019). The first clear instantiation of a V-form organisation is the IBM-Maersk joint venture, TradeLens. TradeLens launched in January 2018 and integrates firms along a supply chain into a single, shared, but distributed and decentralised ledger of information about the provenance and attributes of goods travelling along that chain. This allows V-form organisations to capture some of the value of vertical integration – trust around information as it moves across supply and production chains (Williamson's reduced opportunism) – without bearing the well-known costs of vertical integration – which derive from the effects of hierarchy on management and organisation. A potentially more consequential but more experimental corporate form is the distributed autonomous organisation, a constitutional rule-order that enables democratic or quasi-democratic governance without a central authority.

There is a predicted second-order-effect here as well that operates on the policy institutions that evolved in response to the rise of corporate and government hierarchy. The long-run historical effect of blockchain technology is to disrupt the economic value of hierarchy, particularly large organisational forms. We call this process of dissolution of hierarchy across both public and private sectors 'dehierarchicalisation'. Specifically, blockchain will disrupt (perhaps slowly at first, but inevitably) the

long-run evolutionary capitalist dynamic that worried Marx and Schumpeter, namely the tendency of large hierarchical organisations to accompany industrial innovation. Schumpeter's concern was that the growth of hierarchy and administrative processes impeded creativity and induced regulation, ultimately stymying entrepreneurial dynamics.

Blockchain adoption envisages a market society with weaker tendencies to corporatism, and therefore with fewer of the public policy reactions to corporatism (e.g. market regulation, industry and innovation policy) that have contributed to the growth of the State during the 20th century. By inducing disintermediation and dehierarchicalisation—the first-order Coase-Williamson-Ostrom effects—blockchain technology will unpick the rationale for much modern economic policy. We propose in this paper a new historical model of the impact of blockchain technology on the long-run evolution of market capitalism that is based upon a reduced demand for hierarchical organisation and the follow-on effects this has on the demand for economic policy. Blockchain can thus be understood as a further phase of the evolution of capitalism as technology-induced disintermediation and dehierachicalisation further induce economic policy retreat.

We distinguish between a pre-blockchain era of global market capitalism, and the post-blockchain era, which we are now entering. The post-blockchain era—*viz*. capitalism after Satoshi—is characterised not only by a Coasean shift in the institutions of capitalism toward markets and away from hierarchy (as argued by Catalini and Gans, 2018; Davidson *et al*., 2018; de Filippi and Wright, 2018; Beige 2018), but also by a second-order effect which is a reduced demand for what is broadly industry and innovation policy. In effect, industrial innovation induces innovation policy, a co-evolutionary process that can be observed playing out through the 20th century. Our theory is that blockchain technology will disrupt this epochal coevolution between waves of industrial technology, organisational hierarchy to exploit these innovations, and policy to control the organisations. This is because blockchain is in effect a new type of technology—an institutional or governance technology (Davidson *et al*., 2018)—that inserts itself into this coevolutionary process by disrupting the formation of hierarchy in consequence of industrial innovation, and thus mitigating the need for policy to control hierarchy, as well as for corrective policy to restore the dampening effect of market regulation on innovation.

5. Conclusion – policy after Satoshi

Much of the regulation and policy intervention over the past 100 years has been introduced to deal with the emergence of governance structures within the economy. These governance structures have evolved in response to growing market size, specialisation, and the division of labour *and* the need to manage or suppress opportunism. Regulators and policy makers have focused on mitigating the effect of corporate hierarchy and its second-order consequences – agency problems between shareholders and management, management and staff; market dominance, monopoly and monopsony; imbalances of

bargaining power between management and employees; the opacity of the corporate veil for regulators, shareholders, and consumers alike; divergent interests regarding the quality and safety of products between firms and consumers; and so forth.

The first wave of progressive reform focused on mitigating these problems. Shareholder protection laws were introduced to protect shareholders from managerial opportunism. Labour laws were introduced to prevent workers from being exploited by firms. Consumer protection laws were introduced to protect consumers from corporate opportunism. Prudential laws were introduced to protect taxpayers from banking crises. The list goes on. (We do not deny that many of these regulations and policies were also motivated by rent-seeking behaviour and the like. Whether or not these regulations and policies are entirely necessary, or under-enforced or over-enforced or regulators captured is not a debate that we wish to enter into now.) To the extent that these business regulations and policies exist to suppress opportunism or create an environment of trust, we predict that the nexus of opportunism and trust will shift as a result of blockchain technology. The second wave of policy reform sought to mitigate the consequences of the first wave – with its complex kludge of the mixed economy – for innovation. Intervention begets intervention, as Mises (1977) understood (see also Sanford, 1997).

So what does policy look like in a post-Satoshi world? Distributed ledgers sever the historical dynamic described in Table 1. Regulatory interventions intended to mitigate the dominance of hierarchical governance will no longer be as salient. Anti-trust and other competition law that sought to prevent monopolisation of industries will be unnecessary when markets are more contestable and economic organisation more diverse. Companies and labour law that posited asymmetric information or unbalanced bargaining power between shareholders, employees and management will be likewise less salient. Dehierachicalisation reduces not only the demand for intervention and regulation but its mechanisms. Much intervention has relied upon the existence of hierarchical organisation for its implementation. For example, collective bargaining in industrial relations requires representatives of 'management' and representatives of 'labour' to sit on either side of the negotiation table. Regulatory controls around labour standards – such as the minimum wage – require management to 'govern' labour in a way that is not possible for independent contractors (who can accept payment for service that might result in a below-minimum hourly wage). Much intervention only applies to economic activity above a given size threshold (such as firm' annual turnover or employee numbers). With this reduction in demand for the first wave of policy, we predict a reduction in demand for second-order policy interventions that have been developed to mitigate the consequences of the first wave – such as innovation policy.

The long-run historical effect of blockchain technology is to disrupt the economic value of hierarchy. This is the dehierarchicalisation effect. While still in the early stages of development, blockchain technology is beginning to reshape a range of industries through its effect on new technologies and

business models for payments and finance, supply chains, identity management, record keeping, auditing and verification. We are also starting to see growing policy concern with how to regulate cryptocurrencies and the administrative, legal and tax treatment of blockchain-based contracts, organisational forms, and new classes of digital assets.

In this paper we have used institutional economic analysis to predict the long-run economic and policy consequences of wide-spread adoption of blockchain technology, which we identify as an institutional technology (Davidson *et al*., 2018). The first-order structural economic consequences of blockchain are, we predict: *disintermediation* effects in markets; *dehierarchicalisation* effects on organisations; and substitution from public provision toward private or club provision of trade-governance *institutional infrastructure* for the manufacture of trust (e.g. identity and asset registries, value transfer platforms, and monitoring, arbitration and regulatory functions). We consider how these first-order structural economic effects (disintermediation, dehierarchicalisation, and private infrastructure) have second-order consequences for economic policy—especially competition, innovation and industry policy. The origin for much modern economic policy is an adaptive counterbalancing response to market and organisational externalities of the dynamics of industrial capitalism. Therefore, if the externalities that caused the policy response are removed, then so too is the policy rationale. Blockchain adoption is beginning a process of entrepreneurially unwinding layers of accumulated market intermediation and organisational hierarchy and is laying down new economic infrastructure. This predicts reduced demand for economic policy to readdress the negative consequences of industrial capitalism in the specific context of macroeconomic policy, competition policy, industrial regulation, and industry and innovation policy. Capitalism after Satoshi will be flatter, more distributed, and less regulated.

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