

Trustless architecture and the V-form organisation

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Abstract: Blockchain (distributed ledger technology) is an institutional technology that allows trust to be manufactured instead of being earned. Trust is an important component of business and trade and has previously been subsumed into information costs. It is only now that the importance of trust is being fully appreciated. Arun Sundarajaran has suggested that the creation of new forms of trust has driven the expansion economic activity throughout history. In this chapter we argue that the industrialisation of trust is going, again, to drive a massive expansion in economic activity through the emergence of new organisation forms that will deliver high-powered market incentives deep into what would appear to be hierarchical organisations. We are labelling these (as yet speculative) organisations forms the "V-form" organisation. In this chapter we discuss the importance of trust, the evolution of trust, and the industrialisation of trust. We argue that current organisational forms have exhausted the levels of trust that have previously sustained them. Blockchain technology offers a new industrialised form of trust that can drive further economic activity.

Introduction

Trust is important. Trust is valuable. Yet surprisingly economists have not had much to say about trust. It has taken the emergence of a radical new technology – distributed ledger technology or blockchain – to highlight the centrality that trust plays in almost all economic behaviour. In this chapter we discuss the importance of trust, the evolution of trust, and now the industrialisation of trust. We argue that the ability to industrialise trust will have as far reaching impacts on the economy as the industrial revolution had on the pre-industrial economy. Until the invention of reliable sources of energy production energy to perform work mostly came from animals and humans. Windmills and watermills and the like existed but were either unreliable or immobile. Over the last 300 years or so the existence of cheap and reliable energy has completely transformed our world.

We believe the blockchain has provided us with a form of cheap and reliable trust. In the next section we discuss what trust is. We then explain how trust is currently produced and how the production of trust and the institutions of trust have evolved. Finally we explore the notion of trustless organisation.

What is Trust?

Adam Smith (1776) claimed that humans had a unique characteristic, “the propensity to truck, barter, and exchange one thing for another”. The basis of an economy is trade – the exchange of one thing for another. That in turn implies the need for cooperation. As Smith explains:

In civilised society he stands at all times in need of the co-operation and assistance of great multitudes, while his whole life is scarce sufficient to gain the friendship of a few persons.

Economists have spent their time since Adam Smith mostly expanding on those comments. How does trade improve human flourishing? What mechanisms facilitate co-operation? In 244 years economists have developed a sophisticated understanding of how the price mechanism facilitates trade, how competition disciplines the price mechanism and producers, how governments intervene to correct so-called market failures and the like.

Of particular importance is a strand of literature that builds upon the insights of Ronald Coase and Oliver Williamson. These two Nobel laureates (1991 and 2009) identified and operationalised the notion of transaction costs as inhibiting trade and the gains that can be made from cooperation. Transaction costs have been traditionally broken up into trading costs and information costs. Trading costs are the costs of acquiring trading partners, negotiating agreements, and safeguarding those agreements. Information costs are the costs of acquiring, communicating, and securing information. Harold Demsetz is an economist that spent a lot of time explaining the role of information costs in the economy.

What economists have not been particularly good at is recognising and discussing the role of trust in the economy. In many senses, trust was probably treated as being akin to an information cost. It is increasingly apparent that trust, however, should be considered separately from information costs. Klein (1997) recognises this problem:

It is one thing for theorists to explain how agents decide what promises to make, another to explain why they keep promises. There has been relatively little emphasis on the *integrity* of the activities. The simple explanation for integrity would seem to be that agreements are enforced by courts and constable, but everyday experience and numerous scholarly studies suggest that official contract enforcement is often costly and impractical, yet promises usually work out nonetheless.

... Decentralized interaction implies asymmetry of information, and hence problems of trust, but the invisible-hand result would seem to depend on their being resolved.

The collection of papers contained in Klein (1997) suggest that reputation is the solution to trust problems – itself a function of asymmetric information – and human communication, actually gossip, is the mechanism that disciplines reputation. In addition mechanisms and institutions that restrain breaches of trust and reputation often generate profit opportunities and become self-sustaining. In this type of argument the invisible hand is accompanied by an “invisible eye”. Clearly trust is important and it resolved in many situations, no doubt at some cost.

In the same year La Porta et al. (1997) provided some empirical evidence for the importance of trust. In the first instance they begin by adopting a definition of trust drawn from the political and sociological literature – trust is “the propensity of people in a society to cooperate to produce socially efficient outcomes and to avoid inefficient noncooperative traps ...”. Importantly they point that that trust is

especially valuable amongst strangers – people who have no knowledge of each other’s reputation. La Porta et al. (1997) then provide empirical evidence consistent with the hypothesis that economies with higher levels of trust have larger organisational forms. That result is somewhat intuitive, but the measure of trust that they employ is very rough and ready. Data for trust are drawn from the World Values Survey that reports data for the question, “Generally speaking would you say that most people can be trusted or that you can’t be too careful in dealing with people?” Trust, however, is situation specific. One might believe that people are generally trustworthy, but still lock their homes at night. Or they might believe that people are not trustworthy but Joe the grocer is trustworthy.

Analysis such as La Porta et al. (1997) can be thought of as being more sociological studies. Guiso et al. (2004, 2008) also perform sociological type analysis – the impact of trust and social capital on the use of financial contracts and participation in stock markets – but they begin to think of trust as an economic phenomenon. Guiso et al. (2004) model trust as the subjective probability that a broker will abscond with money, while Guiso et al. (2008) define trust as the “subjective probability individuals attribute to the possibility of being cheated”. Gennaioli et al. (2015) have a slightly different definition of trust – “reducing investor anxiety about taking risk”. Unlike previous studies Gennaioli et al. (2015) have an economic theory of trust:

Critically, we do not think of trust as deriving from past performance. Rather, trust describes confidence in the manager that is based on personal relationships, familiarity, persuasive advertising, connections to friends and colleagues, communication, and schmoozing.

They model trust as reducing the utility cost of an investor undertaking an investment with a given fund manager. While none of these authors quote Lord Keynes (1937) their treatment of trust follows from his definition of risk: [The] “doubts in his own mind as to the probability of his actually earning the prospective yield for which he hopes”. Trust alleviates or ameliorates the doubts in an investors mind that they will earn the return for which they hope. In this view of the world trust is a measure of risk. Trust, then, can be thought of as being the doubts that a transaction will be executed as negotiated.

This formulation of trust may strike some readers as being somewhat counter-intuitive. After all trust is normally considered to be a “good thing”, however, having to trust that a counter-party will actually perform their side of a bargain rather than simply know that they will perform is a vulnerability. Werbach (2018) defines trust as being “confident vulnerability”. Similarly Hurwitz (2013) provides a pithy definition of trust as being “reliance without recourse”. Importantly he argues that trust is “an intangible and important coordinating principle that [facilitates] interactions ...”. In short, the prior existence of trust leads to greater cooperation while the need for trust may impede cooperation.

There are two broad reasons why a contract may not be executed as negotiated. Williamson has discussed both reasons, but mostly focussed on one of the two reasons. Fellow Nobel laureate Oliver Hart has focussed on the other. Opportunism and maladaptation are likely to cause contract execution to deviate from their expected and negotiated outcomes.

Williamson (1985) has defined opportunism as being “self-interest seeking with guile”. In the standard economic model individuals are self-interested, yet honest. Economic agents do not lie, steal, or cheat. In such a world it is not surprising that economists have not explicitly thought much about issues of trust. While Williamson adds other variables to his analysis (see Davidson and Potts in this volume) it is clear that opportunism is the determining factor in his theory (Williamson 1985):

Governance structures that attenuate opportunism and otherwise infuse confidence are clearly needed.

The implications of a lack of opportunism are quite profound – Williamson (1993) argues, for example, that “most forms of complex transacting and hierarchy vanish”. It does seem, however, that Williamson differentiates between trust and a lack of opportunism. Williamson (1993) suggests that “[t]rust is sometimes treated as an antonym for opportunism” but thinks this view is not quite correct. His view being that calculated cooperative behaviour is not trustworthy behaviour. In a purely philosophical sense this may well be correct – yet it is also the case that calculated cooperative behaviour is consistent with confident vulnerability.

Maladaptation relates to a “shifting contract curve” (Aoki 1983). Aoki (1983) suggests that a shifting contract curve is due to the “optimal” contract deviating from the agreed contract over time. As circumstances in the real- world change over time, so the contract that individuals would have entered into changes from the one that they did negotiate. This deviation between the negotiated contract and the otherwise ideal contract imposes costs on, at least, one of the parties to the contract. At this point, the adversely affected party may wish to renegotiate the contract – they may trust that the other party may do so – but could be subject to a hold-up problem.

It is due to this potential for a hold-up to occur that Oliver Hart – the 2016 Nobel laureate – argues that there is more to the firm than simply contracting – there must be ownership of non-human assets. Hart’s insight builds upon conditions well explained by Oliver Williamson. Bounded rationality leads to incomplete contracting which can in turn result in maladaptation costs being incurred over time. The presence of asset specificity makes re-contracting necessary (otherwise the firm could simply terminate the existing contract, with or without penalty, and put a new contract out to tender). The presence of opportunism makes the recontracting process expensive for the party experiencing the maladaptation costs.

In his Nobel Prize lecture Hart provides the following example:¹

Consider a power plant that locates next to a coal mine with the purpose of burning coal to make electricity. One way to regulate the transaction is for the power plant to sign an arms-length long-term contract with the coal mine. Such a contract would specify the quantity, quality, and price of coal for many years to come. But any such contract will be incomplete. Events will occur that the parties could not foresee when they started out.

For example, suppose that the power plant needs the coal to be pure but that it is hard to specify in advance what purity means, given that there are many potential impurities. Imagine that ten years into the relationship, ash content is the relevant impurity and that high-ash-content coal is more expensive for the power plant to burn than low-ash-content coal but cheaper for the coal mine to produce. Given that the contract is incomplete, the coal mine may be within its rights under the contract to supply high-ash-content coal. The power plant and coal mine can, of course, renegotiate the contract. However, the coal mine is in a strong bargaining position. It can demand a high price for switching to low-ash-

¹ Oliver Hart, 2016, Incomplete Contracts and Control, Nobel Prize Lecture, available at <https://www.nobelprize.org/uploads/2018/06/hart-lecture.pdf>

content coal. The reason is that the power plant does not have a good alternative: it may be very expensive for the power plant to transport coal from a different coal mine given that it is located next to this one.

This is an example of the hold-up problem. Once the two parties have entered into a contract and have become mutually dependent upon each other the “fundamental transformation” has occurred and a competition situation has become a bilateral monopoly situation. Hart identifies the challenge here as being that the mine owner has residual ownership rights over the mine. The owner gets to decide what quality coal is produced by the mine in the absence of any other contractual obligation. The solution that Hart proposes is that the power plant buy the coal mine. Ownership of the coal mine resolves the hold-up problem in favour of the power plant – but at the cost of blunting market incentives at the coal mine. In the Hart example, the power plant’s business model is to burn coal to generate, and then sell, electricity. In order to do so, it must own the coal mine. In principle, it should also own the generators.

While Hart does not perform this particular exercise, it is possible to flip the analysis. What asset(s) does a firm need to own in order to develop a profitable business model? We define that asset as being the firm’s “Hart asset”. A Hart asset is an asset that the firm cannot trust someone else to own. In this story the firm becomes a nexus of contracts that maintains ownership of a Hart asset that can be leveraged into a profitable business plan.

The entrepreneurial function then is two-fold: identifying, developing or securing a Hart asset and then developing a (profitable) business plan that leverages off the ownership of that Hart asset. It is important to recognise that ownership of the Hart asset *per se* is not the business model. The Hart asset will be a specific asset (asset specificity in Williamson’s terminology) to the firm but it may not necessarily be the highest earning asset in the firm or be at the point of sale in the business model. The absence of ownership over that asset, however, ensures that the long-term profitability of the business model is compromised.

The Institutions of Trust

Kevin Werbach (2018) has described trust as having an architecture – “the institutional structures for managing trust”. The first such architecture is “peer-to-peer” trust. This is form of trust we are all familiar with – individuals trust (or not) other individuals that they know well. This is a form of trust that is built upon information and knowledge of past performance and consequently expectations of future performance.

Peer-to-peer trust requires individuals to engage in mutual monitoring. Yuval Harari (2014) argues that language developed amongst humans for the purpose of gossip – a mechanism to engage in mutual monitoring and to communicate that information and knowledge to others. This argument is consistent with Richard Posner’s (1981) argument “primitive” societies deny rights to privacy to reduce information costs associated with mutual monitoring. The limits of peer-to-peer trust, however, are quickly exhausted.

Werbach (2018) also describes “Leviathan” as a trust mechanism and “Intermediaries” as providing trust. The State provides many rules and directives and institutions such as courts of law that have the net effect of encouraging greater cooperation amongst individuals. These rules, directives and mechanisms provide greater levels of certainty and so create trust by suppressing some forms of

opportunism and similarly reducing the doubts in individuals mind that contracts will be executed as negotiated. This could be described as being the imposition of trust in order to expand the economy.

Intermediaries provide trust as a service. This requires them to invest in earning a reputation for being trustworthy and then leveraging that trust into their business model. Werbach does explicitly discuss civil society as being a source or generator of trust but he does include the emergence of social norms and behaviours in his discussion.

Another way of conceptualising the architecture of risk is to imagine the Werbach structures as overlapping institutions. So peer-to-peer trust co-exists with social norms and conventions and intermediaries and leviathan simultaneously. There is web of norms, practices and institutions that manage risks associated with the need for trust in various human interactions. The full extent and scale of those human interactions are limited by the extent of trust. That is to paraphrase Adam Smith's insight that the division of labour is limited by the extent of the market. Trust is expensive to create and maintain and when the limited of trust are reached the limit of human cooperation is also reached.

That insight is neatly encapsulated by Arun Sundararajan (Reinvent 2016):

If you look back at history, every time there was a big expansion in the world's economic activity, it was generally induced by the creation of a new form of trust.

The development of language, writing, double-entry book keeping, contract law, courts of law, consumer protection legislation, the joint-stock company, the regulatory state, mandatory auditing and so on are all mechanism that have emerged or been designed to manage and overcome trust problems.

Economic activity takes place across three organisation forms; markets, firms, and government. Each of these organisation forms has developed webs of trust that overlap and reinforce each other. What is important for the subsequent discussion is that markets tend to characterised by horizontal relationships – buyer and sellers tend to have equal relationships. Firms and government tend to be characterised by vertical relationships – relationships are characterised by hierarchy.

What economists have failed to fully appreciate until recently is how those organisational forms are moderated and moulded by trust, the need for trust, and the importance of trust. Economists have also failed to fully understand just how expensive can be. Davidson et al. (2018) have estimated that trust accounted for 35 per cent of US employment using 2010 employment data. That is 35 per cent of all US employment existed to generate, maintain and enforce trust. That figure extrapolated to the global economy would represent some US\$29 trillion. In short – trust is expensive.

Distributed ledger technology – blockchain – has the potential to revolutionise the economy by creating yet another form of trust. *The Economist* (2015) has described the blockchain being “a trust machine” while Swan (2015) has described the blockchain as being “trustless”. That latter characterisation, however, is not entirely correct. Rather the blockchain creates “industrialised” trust.

Berg et al. (2019b) have explained how a proof of work type distributed ledger industrialises trust by creating a three-sided market. This type of distributed ledger must simultaneously meet the needs of three groups of users – buyers, sellers, and miners. In this type distributed ledger the miners secure the network by applying computing power and burning electricity. The proof of work mechanism transforms expensive work into trust in a mechanised manner and at industrial scale. Berg et al. are able

to show that a proof of work distributed ledger is able to suppress many forms – but not all – of opportunism and so would expand the number of transactions that are currently not undertaken due to high trust problems.

It is likely the case that many more transactions will occur than would otherwise, and that the relative comparative advantages that firms and government currently enjoy over each other, and over the market will be eroded.

Trustless Organisation

In the late 1980s and early 1990s Thomas Malone (and various co-authors) posited an “electronic markets hypothesis” that suggested that information technology would drive a revolution in industrial organisation resulting in a greater proportion of economic activity occurring in markets as opposed to firms. In a 2011 interview marking the 20th anniversary of the electronic markets hypothesis (Wigand 2011) it was put to Malone that the emergence of organisations such as Amazon, eBay and Google represented evidence in favour of the hypothesis.

In a 2003 book chapter Malone revisited the electronic markets hypothesis. Rather than arguing for a choice between hierarchies and markets, he argued in terms of centralised versus decentralised decision makers and the factors that will affect the choice between decision-making structures: decision information, motivation, and trust. In particular he argued that decentralisation is desirable when decision makers have access to information that cannot easily be centralised, when decision makers have the motivation to make decisions at the local level, and when local decision makers do not trust central decision makers.

It is this last condition – what Berg et al. (2019b) label the “Satoshi condition” – that is important. Local decision makers not trusting centralised decision makers is common. It is only after the advent of viable distributed ledger technology that a solution to that problem has become viable. Malone had based his prediction on a fall in communication costs – Berg et al. (2019b) argue that the electronic market hypothesis is driven by a fall in the cost of trust.

Given that existing organisation forms are moulded and moderated by mechanisms that create and sustain trust, it can be expected that any new form of trust can and will erode the comparative advantage of existing organisation forms (hierarchy) and create new forms of organisation. As yet distributed ledger technology has not penetrated many organisations and many usages are still being trialled for adoption. As such any discussion of how distributed ledger technology will be adopted and enter widespread usage must be speculative.

In the first instance we imagine that a new form of industrial organisation will emerge. Alfred D. Chandler Jr (1962) has described the change in industrial organisation following the industrial revolution as being a movement from the so-called U-form organisation to the M-Form organisation. With the industrialisation of trust, we imagine the emergence of a “V-form” organisation. Following Berg et al. (2018, 2019a) we define a V-form organisation as being an outsourced, vertically integrated organisation tied together not by management and corporate hierarchy but by distributed ledger technology (i.e. a blockchain). The V-form organisation would consist of a group of (otherwise) fully independent companies effectively operating as a single vertically integrated organisation. The V-form aspect of this organisational form utilise distributed ledger technology to coordinate and audit what would have been previously done either through the corporate office or in the market.

The idea of a ‘virtual organisation’ where firms are virtually connected to each other through information and communications technologies dates back at least to the 1980s (see Miles and Snow 1984, 1986). Riemer and Klein (2012) have identified that a major barrier to value creation through a V-form organisation was the existence or creation of social capital that would foster the necessary trust in a distributed network – this is the “Satoshi condition” discussed above.

Trust that previously had been generated through hierarchy would now be generated through the use and deployment of distributed ledger technology. Many forms of vertical integration would now become redundant. Firms pursuing size as a business strategy would be outcompeted by smaller more nimble firms. Those aspects of business operations that can be contracted in an industrialised trust environment will be contract in firms and not within hierarchy – Hart assets, however, will remain within each firm. Actually establishing which assets are Hart assets and the business models that operate off those assets will be an entrepreneurial discovery process.

Based on that observation we expect that many existing vertically integrated firms will “dehierarchialise” (See Berg et al. forthcoming). Those firms where size is not a function of economies of scale will become smaller. Extant large firms will be replaced by V-form operations where large scale operations will occur by having many smaller firms cooperating across a blockchain enabled platform. We are beginning to see the sprouts of such organisations throughout the global economy, beginning initially in the management of lengthy supply chains.

The V-form organisation has implications for corporate strategy and organisation, but longer-term implications for regulation, public policy, taxation, and even the shape of global capitalism.

Oliver Williamson argued that a core benefit of the M-form organisation was how it drove management to behave differently than it would in a unitary firm. But when Chandler and Williamson were writing, the M-form was an established part of the American and global business landscape. We believe V-form organisations are emerging as we write, in real time (mostly in the supply chain space). As we write these words in 2020, firms have the opportunity to adjust their strategy to a V-form world before they are forced to do so. Here we draw four implications for business strategy.

Where previously management had a choice between make (insource) or buy on the market, they now face a choice as to whether to make, buy, or network. Firms integrate partly to reduce opportunistic behaviour between suppliers – that is, for trust reasons – the risk of which grows as production and logistics lines become more complex. That complexity is an information complexity. It is harder to guarantee quality (that is, provide information about quality) through market exchange. Until now the choice has been to buy quality through complex and incomplete contracts or bite the bullet and acquire the supplier, often incurring significant administration costs. Cooperation involving a distributed ledger technology provides many of the benefits of consolidation – trust – without the costs in administrative bloat and inefficiency.

A subsequent downstream prediction of the V-form organisation is the reduction in competitiveness of large unitary and multi-divisional companies large integrated firms. Where firms have consolidated for reasons of ensuring trust in information about provenance and quality throughout the value chain, blockchains offer a potentially cheaper and more efficient alternative. After decades of consolidation and mega-mergers, we predict decades of de-consolidation and de-mergers. The problem with mergers isn’t that synergies or back office savings between merging firms do not exist, it is that their value relative to the costs of consolidation (potential cultural clashes, leadership weaknesses, difficulty in

driving structural changes) are typically overestimated. In the near term future many production line and supply chain synergies will be realised through V-form organisation rather than hierarchal consolidation. The result will be the hollowing out of hierarchy throughout the corporate world, with profound economic, and even political consequences.

In the U-form organisation, where divisional profits are opaque, decision-making is more discretionary and management jostles amongst each other for status and discretionary budgets. The M-form organisation suppresses these bureaucratic, non-profit characteristics inside the for-profit entity by exposing divisions to an internal capital market. The V-form organisation would drive high powered incentives deeper into the organisation as they are restructured and reorganised into separate, networked organisations.

The V-form organisation, however, would not be a one-for-one replacement of the M-form organisation. M-form organisations tend to be horizontally integrated across distinct (although hopefully complementary) divisions or jurisdictions. A V-form organisation would consist of vertical rather than horizontal coordination. To date the supply chain management applications have focused on cross-border supply chains with extremely heterogenous firms (the Kenyan flower farm, the Danish shipping fleet, the Rotterdam flower wholesaler) that are unlikely to be candidates for vertical consolidation even under the M-form. Business strategists looking to exploit the opportunities for V-form organisation should look at their firm's structure and position in the market through the prism of a supply chain of information – where the boundaries of firms and subsidiaries are built around questions of trust and where systems and organisations have been developed to limit opportunistic behaviour by employees, managers or market counterparties. It is at these links in the chain within and between firms that a new trust technology can potentially be used.

Where would firm boundaries lie? As firms deconsolidate managers will have to focus much more on their asset specificity and their Hart asset. What asset, or capability, or attribute or core competence is it exactly that drives their profitability? V-form organisations will only consist of those specific assets and capabilities. Everything else can be spun-off or sold off and recontracted through the V-form. The challenge facing many managers at present is that they are often unsure as to what exactly their profit drivers are. Managers may know where they earn a profit but not always why they earn those profits. Construction firms, for example, might think they earn their profit through superior contract management but could actually make their money by offering engineering services. In the V-form organisation the contract management function will be performed by the blockchain via smart contracts but the ability to deploy engineers to solve unique problems will still be a valuable service. As the V-form organisation industrialises trust and drive high-powered incentives deep into existing organisations we expect to observe the emergence of highly specialised and focussed organisations that only trade in their core competence.

Then we can imagine implications for policymakers. The twentieth century established a triumvirate relationship between employers, (unionised) labour, and labour market regulators – big business, big unions, and big government. That relationship reduced the costs of negotiating between these large sectors, facilitating the corporatist labour market regulation of the second half of the twentieth century. A combination of labour market reform and structural economic shifts (including those towards services and the digital economy) has gone a long way to undermining this dynamic, eroding the political economy foundation of regulation. De-consolidation will not be evenly distributed across the value chain, but in many cases the large firms will be replaced by networks of SMEs, and SMEs replaced by networks of individual contractors.

This will put further pressure on labour market regulation or place large swathes of employment outside the jurisdiction of labour regulators. We can already see the sprouts of such regulatory dilemmas in disputes about the “gig” or sharing economy, where it is disputed whether Uber drivers should be seen as independent contractors or employees of Uber (and therefore subject to regulatory standards like the minimum wage, etc.). These relationships can be either treated as a new category of “employment” – platform engagement – or governments will have to accept that the more lightly regulated category of independent contracting will come to dominate the labour market. Either way, it will be harder for governments to deliver rent to favoured labour constituencies or to offer social services through labour relationships. This has the potential to threaten established social safety nets and reduce labour market controls.

The V-form organisation will disrupt established global tax cooperation. The prototypical M-form organisation is the multinational conglomerate, with autonomous subsidiaries in each jurisdiction. This allows firms to tailor their operations to local conditions and regulatory requirements. Within that organisational framework, firms have discretion to locate economic activity in lower-tax jurisdictions. The shift of value to intellectual and digital property has boosted this capacity. Two decades of regulatory efforts around global tax coordination (for example, the OECD’s Harmful Tax Competition program in the 1990s and the Base Erosion and Profit Shifting program in the 2010s) have sought to control transfer pricing and other strategic tax behaviour (see Berg and Davidson 2017).

The effect of the V-form organisation on these structures is contradictory. On the one hand, the decline of the multinational conglomerate and de-consolidation will encourage more cross border financial trade as firms which were under one opaque corporate roof now exchange value between distinct firms. This ought to make economic activity more transparent to taxation authorities – a reversal of the trends that we have seen in the last two decades. On the other hand, technologies of trust allow firms to minimise and even eliminate their administrative and corporate footprint in jurisdictions where they have customers. Many structures that maintain national subordinates will ultimately have no legal presence in major economies, where instead they can deal at arms-length with local agents that perform the minimum viable activity to service local customers. We expect to see in this circumstance substantial redistribution of tax revenue around the world, further favouring low-tax jurisdictions and disfavouring certain taxes (such as corporate and sales taxes).

Competition policy will focus on protocols rather than firms. Large firms played a coordination role in the economy of the twentieth century and returns to scale on that coordination risked the monopolisation of large sectors in the economy. In a V-form organisation, that coordination role is played by protocols. What is the role for competition law in this environment? Increasing attention by policymakers to the competition effects of large digital firms (Google, Facebook, Amazon) suggests a move towards anti-trust in this space. However, the decentralised nature of blockchains means that there is not necessarily a large organisation to target with anti-trust action (Schrepel 2019).

In the absence of central organisations, we expect regulators to explore and potentially impose existing third party access regimes that apply to physical infrastructure onto permissioned blockchains. The pivotal question will be how regulators understand firms such as IBM to control the protocol and its access. Regulators may find themselves trying to act against large networks of firms rather than single firms. In principle, a permissioned blockchain that is ‘open’ to firms on a non-discriminatory basis through regulation or public ownership by a (trusted) government could surmount adoption barriers of distributed platforms. The trade-off here will be around how such regulatory controls might impede innovation or competition on other margins.

Pension funds and sovereign wealth funds will face a different investing environment. Technological disruption has already reshaped the investment environment, as capital has moved from traditional economic sectors to technology sectors. But the V-form organisation will reshape the structure of the investment environment. The decline of large (public) companies presents a more heterogeneous and diverse range of investment opportunities. There is likely to be a reduced supply of large publicly investible companies on centralized exchanges. This is a problem for all investors but is particularly pernicious for large government-backed investors such as pension funds and sovereign wealth funds. Public funds may need regulatory changes in order to operate in this changed environment. Public and private investors are going to need to learn to operate more as venture capitalists than institutional investors. This trend will be accompanied by other changes in the investment space, some of which we have already seen: tokenisation of assets opening up large new categories of investible assets, alongside the ability of investors to invest (through native tokens) in blockchain protocols themselves. Policymakers who wish to continue to bind public funds to conservative investment strategies will have to rebalance that preference against a shrinking space for conservative investment.

Conclusion

The creation of new forms of trust – new institutions that generate trust – is the story of economic progress. Arun Sundararajan’s insight is profound. Our ability to truck, barter and exchange one thing for another has evolved over time from actual barter to electronic commerce. The goods and services that we exchange have become sophisticated and abstract. What has not changed, however, is the importance of trust in facilitating trade. New forms of trust have made possible more sophisticated trade.

Throughout human history trust has been expensive to produce and easily depreciated or destroyed. While we do not explore the arguments here, there are limits to trust. We live in a world where many of the institutions that generate trust are being seen as increasingly untrustworthy. Distributed ledger technology has the potential to industrialise trust. This in turn should drive the adoption of new products, new services, and new forms of organisation. We have seen this throughout economic history and we stand at a time when an explosion of economic creativity will occur – if not already occurring – as a result of cheap and reliable trust being created at industrial scale.

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