Some public economics of blockchain technology

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1. Introduction

Distributed ledger technology emerged in 2009 as the protocol behind bitcoin, a cryptocurrency with origins in the ‘cypherpunk’ community who sought to use cryptography to secede from government control of money (Narayanan and Clark 2017). Bitcoin’s pseudonymous inventor, Satoshi Nakamoto (2008) said Bitcoin would be “very attractive to the libertarian viewpoint” and many in the crypto-anarchist community saw, and still see, cryptocurrencies as a means to free citizens from the monetary depredations of governments (Popper 2015). But from these revolutionary secessionist origins, it has become apparent that not only are there many possible use cases of distributed ledger technology for government (Walport 2016), but that government action through both regulation, legislation, and public investment might be a key factor in the adoption and development of this technological innovation. Governments can use blockchain technology to exploit the service efficiencies they may bring. But also, and perhaps counter-intuitively given their revolutionary origins, private blockchain applications are likely to need government cooperation to facilitate adoption and the development of the blockchain economic system.

Davidson et al (2018) characterize blockchains as an institutional technology rather than a general purpose technology (see also Berg 2017). One consequence of this characteristic is that blockchain applications tend to interact with existing regulatory frameworks. A growing number of smaller countries or autonomous regions have moved to position themselves as broadly friendly jurisdictions for the development of this new technology. Great Britain (Walport 2016) and Australia (Data61 2017a, 2017b) have issued high-level science reports on the prospects of the technology. Other smaller countries (such as Estonia) and city-states (such as Singapore) have folded blockchain into a thorough-going digital and e-government investment strategy. City-states such as Dubai and states or cantons such as Zug, Illinois (in the US), and self-governing dependencies (Gibraltar and the Isle of Man) have developed and enacted strategic initiatives to move many aspects of government services to the blockchain, or to create special crypto-economic zones. Singapore and Australia have directed their financial regulators to issue detailed guidance about the regulatory, legislative and tax treatment of crypto-assets, incentivizing the global location of crypto-investment within their jurisdictions. Political leaders in Japan and Russia have made multiple announcements broadly supportive of crypto-investment within their nation.

Most countries still retain a degree of benign neglect, largely due to the relatively small scale of cryptoeconomy presence, or lack of dedicated government interest or capability to deal with these issues (an example is New Zealand). Some regions, however, have adopted a

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relatively hard line in terms of regulatory compliance (e.g. New York State's bit-license) due to immediate pressures created by growing activity within their jurisdictions and the need to remove regulatory and legislative ambiguity. On the other hand, some countries have gone from neglect to outright hostility to the cryptoeconomy, such as China's ban of initial coin offerings and cryptocurrency exchanges. So, where some countries are already seen as more investment-friendly, other countries are equally emerging as difficult places for crypto-investment.

The global geography of the emerging cryptoeconomy is also significant, and traces to national government differences. Much of the development of the cryptoeconomy is also geographically concentrated, especially around Silicon Valley in California. But the distributed nature of the technology means that the relation between the geographic regions that develop and build the technology, and the regions and places that subsequently adopt it is not as strong as might be expected. Which is to say that the geography of invention is not the same as the geography of innovation.

The US, for instance, is highly successful in inventing blockchain technology. Yet it has been finding it hard to adopt because of regulatory complexity. Regulatory agility, particularly in dealing with local vested interests through deregulation or political buy-out, will therefore be a significant factor determining which nations are able to successfully adopt blockchain technology. This favors city-states and smaller countries (Singapore, Zug, Estonia, Australia) because of lower coordination costs. However, pilot programs such as the Illinois Blockchain initiative demonstrate that where dedicated efforts are made, positive results can nevertheless be achieved.

The tax treatment of the cryptoeconomy is also a major unresolved issue. Most countries are still struggling with the tax classification of cryptoassets, and specifically whether to treat these as money (untaxed, but rather taxed as spending),debt or equity (in which case it would be treated as income or gains from a capital asset or investment vehicle). Berg et. al. (2017a) argue that cryptoassets are what Williamson (1988) called 'dequity', and should be taxed as capital assets, not as money. The complexity is that blockchain technology is not just another productivity enhancing technology that can be taxed at the point of adoption. Blockchain adoption (at least at present with cryptocurrencies) is actively associated with tax avoidance or tax shifting owing to the pseudo-anonymous nature of transactions and the difficulty of establishing the correct jurisdiction for taxation.

Interestingly, unlike many new technologies, there are few active programs of government subsidy of blockchain technology development, such as R&D tax credits or industry or research policy. Some exceptions to this do exist. In the past year some governments have started to fund university-based research institutes on blockchain technology. The Australian government has also directed funds to a blockchain energy trading platform, PowerLedger, through its Smart Cities and Suburbs Program (Power Ledger 2017) Furthermore, to the extent that government funding of academic mathematicians and cryptographers produced the initial research papers that were subsequently developed into blockchain technology, then the early development of this technology was publically sponsored (see Narayanan and Clark 2017), but not publically planned.

2. Economics of government support for blockchain technology

To what level *should* government support the development of blockchain technology, and to what extent should government seek to adopt and use blockchain technologies? From a public

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policy perspective, the simple economics of blockchain can be considered using social welfare analysis.

Most new technologies can be analysed from the perspective of uncertainties and positive externalities in private investment and adoption resulting in market failure (Arrow 1962). There is usually therefore an *a priori* case to be made for public support of technology development (or the public creation of artificial monopolies through intellectual property). However, there does not appear to be notable market failure in early investment in blockchain technology, which is instead experiencing a surfeit of private investment flows. This is in considerable part a direct consequence of the design of token sales to incentivise early adoption through built in inflationary mechanisms, such as Bitcoin's periodic halving of mining rewards.

Instead, consider government spending and action to adopt blockchain technologies into its own services. Where blockchain technology is a substitute for an existing technology (such as the provision of money, or property registries), economic analysis of investment and use of substitute technologies should be evaluated by the marginal productivity benefits to the delivery of government services to citizens. This requires identifying specific use cases – such as identity and asset registries, licenses and certification, open government data, reporting and management of government contracts and public assets – and then estimating the marginal cost and benefits of government investment and adoption of this technology. For instance, a Bank of England staff working paper estimates a 3 percent gain in GDP from the issuing of a government crypto-currency owing to transaction and tax efficiencies (Barrdear and Kumhof 2016).

This method should enable calculation of optimal public investment in blockchain technology by the state in order to maximize social welfare, just as with the calculation of the economic benefits of public adoption of any new technology (such as renewable energy) or public infrastructure (such a communications network).

In these calculations, a key parameter is the utility gain to consumers (citizens), which the planner seeks to account for in their (social choice) objective function. A similar argument is made in respect of efficient (Pigovian) regulation of the cryptoeconomy, such that the costs of regulation (in monitoring compliance and enforcement) and the restricted space of permissible economic activities is more than compensated for by the public benefit that accrues through the effects of the regulation in preventing social bads (such as investment fraud). This same argument also holds for effective tax treatment of cryptoassets, whether the objective is (Ramsey) tax maximization, or (Pigovian) minimization of negative externalities.

There are also public goods problems owing to the need for (especially) digital communications and network infrastructure upon which a cryptoeconomy operates, and also public investment in creating open access data regimes and registries that can be harnessed and used by cryptoeconomy businesses and DApps (decentralized applications) as inputs into smart contracts and DAOs (decentralized autonomous organisations). As mentioned above, countries have made different levels of public investment in this sort of digital communications and data infrastructure.

Similarly, countries have made different public investments in establishing high quality legal institutions (regulators, courts, bureaucracies, democratic systems, etc.) resulting in varying degrees of predictability, efficiency, transparency, accountability, corruptibility and efficacy. These make for systematically different transactions costs in using government institutions. In consequence, there will also be different complementary gains to investment in new institutional technology, or benefits of leap-frogging to blockchain technology. These benefits accrue for internal trade and investment within a region or nation, but also to gains from international trade with nations that have made corresponding investments.

In all such contexts, the economics of blockchain public policy is considered from the social choice perspective of the rational planner seeking to maximize social welfare. To the extent that blockchain technology benefits (lower transactions costs, information costs and coordination costs for society, driving productivity gains in delivering existing services, and the prospect of new services) are greater than adoption costs (public investment), then we expect to observe widespread public investment and adoption.

Why might some countries lag behind in social welfare maximizing investment and adoption? Explanations could be based on constraints, such as bounded rationality or information constraints (governments may not know about the benefits, or misunderstand them), or financial constraints (governments might not be able to afford these investments or effectively be able to raise the capital to make these investments).

An interesting further constraint is trust in government itself. Efficiency gains to a citizenry from moving government registries (identity, property titling, tax, voting, central bank coin) to blockchains require a 'trust-fall' in which only high-trust institutions will be able to make the transition to trustlessness. For example, a country such as Haiti might benefit most from moving its property register on to a secure blockchain, but Haiti may lack the high-trust institutions necessary to ensure that the information being put on the blockchain is accurate. By contrast, Sweden has the high-trust institutions necessary for such an approach, but the benefits from doing so are correspondingly smaller. (Sweden has been developing a blockchain land registry since 2016, see Lantmäteriet, Telia Company, ChromaWay and Kairos Future 2016)

A further factor constraining government adoption of blockchain technology is its own capabilities to implement cryptoeconomy infrastructure and to create effective regulatory governance. This will be a function of the quality and experience of bureaucrats in the civil service, or the extent to which governments can access outside skills and capabilities through contracting.

However, a further possibility is that governments that are slow to adopt, or are outright hostile to adoption of this new technology do so not out of ignorance or constraint, but are actively and deliberately maximizing their own objective function, not that of their citizens (as in social choice theory). This is the rational actor model of government, or public choice theory.

3. The economics of governments against blockchains

In the political economy model of government, governments and citizens have distinct objectives that they seek to maximize. Citizens trade votes for services, and governments seek to create benefits for themselves subject to the budget constraint of getting elected. What citizens want and what governments want will be in conflict, resulting in political exchange. The study of this exchange using economic analysis is called public choice theory, and this is a useful framework through which to analyse the interaction between the citizen benefits of blockchain adoption versus the government benefits (and costs) of that same adoption.

A good example is identity (Berg et. al. 2017b). Governments want (or benefit from) a single point of identity (centralised). This is because a single identity is useful for identification of citizens for the claims governments make on them, such as for taxation or conscription (Scott 1998). Every citizen must have one and only one identity from the perspective of the government's objectives. These centralised identity registrations are coopted for commercial identity (e.g. to open a bank account, or to rent a car). But from the citizen perspective this is inefficient, because identity is owned and managed by the state (the citizen has no control over their identity, and cannot choose how to permission and share this data), and this creates problems of trust and privacy (for example in health and criminal records). A decentralized identity would be more efficient, facilitating variety of types of identity for specialized uses, and enabling user control. But governments don't want that; hence the trade-offs and conflict.

In a series of papers Andrei Shleifer (and various co-authors) has developed an institutional theory of regulation (Shleifer 2005 refers to this as the 'enforcement theory' of regulation) that examines four broad governance strategies that 'society' can pursue in order to achieve some objective relative to the trade-offs associated with those strategies. These strategies are; 'market discipline', 'private litigation', 'public enforcement through regulation', and 'state ownership'. The societal trade-offs as being the costs of private disorder and the costs of government dictatorship. Disorder relates to the ability of private individuals to inflict harm on others, while dictatorship relates to the ability of government and its bureaucrats to inflict harm on others. The framework has been applied to productivity and red tape (Berg forthcoming; Davidson 2013), the environment (Davidson 2014), media regulation (Berg and Davidson 2015), freedom of speech (Berg and Davidson 2016), innovation (Davidson and Potts 2015; Davidson and Potts 2016), education (Lane 2017), democracy (Allen et al. 2017), and tobacco control (Davidson 2016). Allen and Berg (2017) emphasise that the dictatorship and disorder costs are subjective.

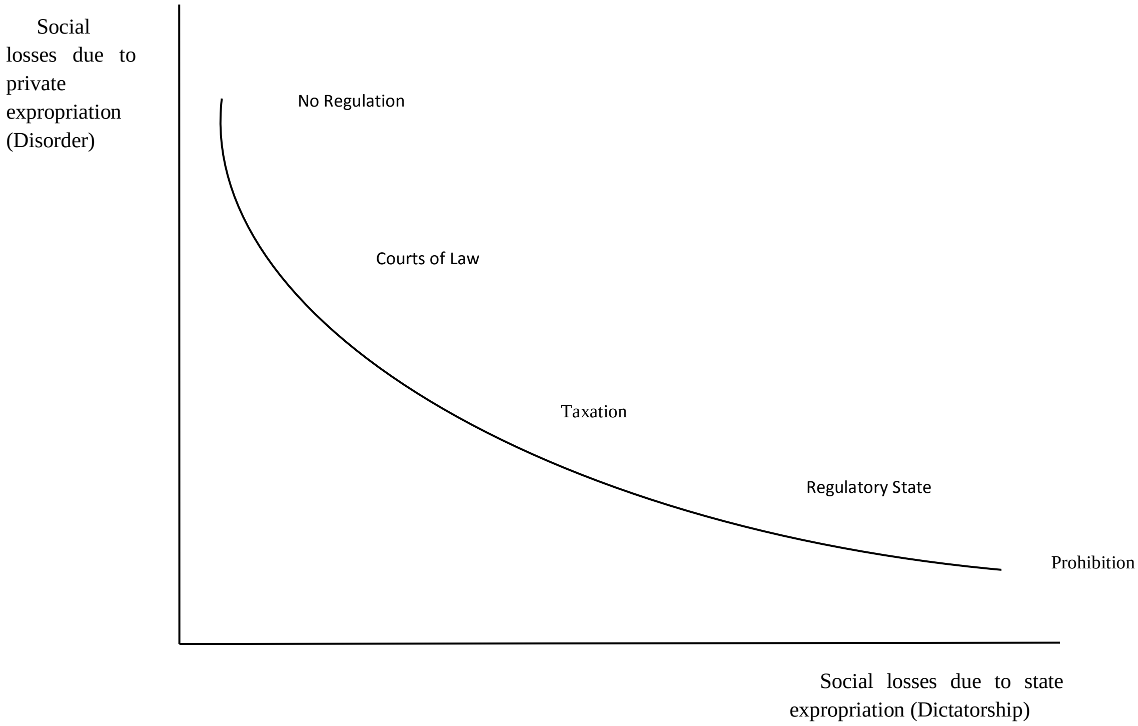
In this framework, market discipline should be considered as the regulatory default. Of course, that is not always possible and at this point the control strategy becomes private litigation. The state begins to play a role as the rules of contract and tort law are administered by courts of law staffed by bureaucrats and judges. Courts of law exist, at this level, to enforce private agreements and to adjudicate disputes between private parties.

Chicago school economists have argued that the combination of market discipline and courts of law should suffice for any regulatory framework. Shleifer (2005), however, has argued that courts cannot always resolve disputes cheaply, predictably, or impartially. This is especially the case when the parties to the dispute have vastly different resources that they can deploy to a legal dispute.

Regulation occurs when the state not only provides a dispute resolution mechanism but also writes the rules that govern economic behaviour and transactions. There is substantial variation in how government can enforce its regulations. It can, for example, allow bureaucrats to engage in a regime of inspection and verification with fines being issued for non-compliance. Alternatively, the state can provide a set of rules that are privately litigated, or publicly litigated. Public litigation can consist of either civil or criminal charges. Similarly the regulatory agency can initiate litigation itself for breeches of the regulations, or act once a complaint has been received. This notion has been extensively debated in the context of financial regulation.

Finally, state ownership appears to be an efficient response to those situations where the disorder costs are likely to be very high. Shleifer gives the examples of prisons, police force, and military where this is likely to be the case. The costs of disorder resulting from private ownership here are potentially so large that government needs to maintain control over these institutions. While Shleifer does not explicitly include prohibition in this category, it is clear that prohibition should be included at this stage of the analysis as being equivalent to state ownership. Figure 1 applies the logic of this approach to the question of blockchains and cryptocurrencies.

Figure 1: An application of social control to the cryptoeconomy



Given the recent emergence of blockchain technology and its experimental nature it is very likely that most crypto-entrepreneurs are of the opinion that their activities are not subject to any regulation. This view is not entirely correct. To the extent that they enter into market exchange (either via the labour market or product markets) they are regulated by existing regulations. The question of interest is whether they should be subject to unique regulations.

That question is best answered by determining whether blockchains and cryptocurrencies are the source of any unique market failure. Economists usually describe market failure as originating from one of three sources: asymmetric information; externality; and market power. The existence of any one of those three factors will lead to a decline in the number of transactions and unrealised gains from trade will persist in the economy. At this point (traditional) economists usually prescribe some or other government intervention to overcome market failure. By contrast, the field of crypto-economics has rapidly evolved and employs incentives, mechanism design, and technology to overcome market failure (Buterin 2017, Stark 2017). Ironically the field of crypto-economics has few economists working within it – most practitioners are computer scientists.

The observation, however, that market failure is not apparent as some might perceive does not distract from the fact that understanding the basics of blockchains and cryptocurrency is a non-trivial task. Consumers do not need to understand the technical details of a technology to enjoy the benefits of that technology. How many people understand how the internal combustion engine works, or how electricity is generated and transmitted? The fact that there are high initial costs to understanding blockchain technology does not mean that it is itself a source of asymmetric information. Indeed blockchains are designed to reduce or overcome asymmetric information and market power problems (Berg et al 2017c).

Similarly, the disruption to existing industry that a blockchain is likely to achieve (and various platform economy applications have already achieved) is not a source of externality. Externality is best understood as being nuisance – a cost imposed on a third-party to a market transaction. The impact of a blockchain on existing business is not nuisance, it is direct competition. In a market economy a new and superior good or service should displace older and inferior goods and services. Of course, it is not always possible to predict in advance what a ‘new’ and ‘superior’ product might be; that depends upon the margins that consumers prefer.

In essence then, our argument is that the blockchain economy is little different from the existing economy in regulatory terms – it imposes no new, unique or additional disorder costs upon the economy. In that respect, it should not be subject to new, unique or additional regulations. It should be regulated *mutatis mutandis* as are existing industries. In the first instance the courts are best placed to enforce those regulations.

The public choice insight is that what citizens want (or would benefit from, and be willing to pay for) is not identical with what governments want. We would therefore expect to observe departures in the levels of public investment and public policy from the social welfare maximum as a function of government self-interest. This helps us to understand why governments might nevertheless be reticent to adopt or support new technologies that their own citizens would value and benefit from.

4. International strategy and crypto-secession

Once we recognise that governments have their own interests in promoting or constraining the cryptoeconomy through public investment and public policy, and allowing that cryptoassets, cryptomarkets, and the productive resources involved are in some degree globally mobile, it follows that there will be a strategic (international) dimension to each governments’ choices. What a government chooses needs not only to be rationally optimal from the perspective of its own citizens, but also a *best response* to the expected moves of other governments. Further complicating this game is the fact that other players (nations) differ in size, level of economic development, and quality of institutions.

Governments, or at least parts of government such as Treasury, will often have some interest in constraining or controlling the growth of the cryptoeconomy, not least because it makes some of its functions (such as taxation) harder. However, the expected response of citizens (including cryptoeconomy companies) depends upon the moves of other countries, especially those that they might credibly seek to exit. Because the most effective public policy settings are not *ex ante* obvious, there are learning costs involved and governments might rationally decide to delay decision making (as a real option strategy) in order to learn from first-movers who can then be expected to incur costly mistakes in the experimental process of policy settings. (From a global social welfare perspective, it is best that the early experimenter countries are those that are representative, but smaller, minimizing the opportunity costs of experiments but maximizing the potential to import lessons.) We would thus predict that larger countries will be much more cautious in adopting crypto-economic poles that are significantly divergent from other countries that are competitors for crypto-investment or mobile assets.

An alternative to unilateral strategy (Tiebout competition) is bilateral or club-like coalitions of strategic investment and public policy harmonization (as in tax and trade treaties, see Potts 2017). This would create crypto-economic unions in which internal distributional consequences could be dealt with through club-level Coasian bargaining and transfers.

When governments impose high dictator costs of centralized control, the exit option at some margin becomes valuable. Blockchain technology facilitates the movement of many aspects of an economy (identity, contract, money and payments, organization, data, etc.) to a decentralized protocol, in part evading centralized control. This makes possible a phenomenon that MacDonald (2016) calls *nonterritorial secession*, or *crypto-secession*. With a federal model of local public goods, people move to jurisdictions that meet their needs, and governments competitively provide these at different offering and price points (Tiebout 1958). If an individual prefers a different bundle of public goods in a federal system, they exit. If a group of individuals collectively prefers a different bundle of pubic goods, they secede. But to secede, they must go somewhere else, which also imposes costs (Berg and Berg 2017). Non-territorial secession is choosing a different bundle of public goods, but without leaving the territory, just opting out of all or part of the government bundle. Crypto-secession is when the new bundle of local public goods is organized, coordinated and delivered through blockchain technology.

An example of such emergent private governance of local public goods might occur at a local or regional level where a group of citizens create a pooling mechanism of social insurance, energy grid, or asset titling management through smart contracts, DApps and DAOs. This is more likely at the local, regional or city level than that of a nation state because of set up costs and self-selection. We would therefore predict that exit adoption of blockchain technology for governance will be a bottom-up phenomenon beginning with small groups.

5. Blockchains and property rights

Blockchain technology may also disrupt the relation between government and property rights. Property rights matter because they reduce uncertainty and entropy in a transactional system. Better property rights improve transactional efficiency and are value-creating institutions.

A fundamental question in the economics of law is whether property rights originate from the state and are then transacted in markets, or whether property rights arise from markets and from economic activity, and is then efficiently enforced by the state? While the former view, called legal centrism, is the most widely held among law and government scholars, public choice and market institutional economists tend to argue for the latter (Alchian and Demsetz 1972, Cooter 1993). Nevertheless, economists do know that property rights interact strongly with governance (Hart and Moore 1990). Crypto-currencies and crypto-assets provide an interesting test of these competing views because it is not obvious what role the state plays in either creating or enforcing the property right claims over these assets.

One argument is that crypto-currencies and crypto-assets have emerged entirely outside state jurisdiction and instead occupy a new software-enforced constitutional governance realm. In this strong form view, these are native crypto-property rights from which there is a risk of government predation. An alternative argument is superficially similar, but allows that this parallel crypto-property rights regime has emerged in-the-shadow-of state law and enforcement and remains private law only to the point of irreconcilable dispute, and which point it reverts back to government enforcement and sanctions. It is unclear where we are at this moment in respect of whether crypto-property breaks the covenant with the state (as a kind of ‘stationary bandit’ model of crypto-property, viz. Olson 1993), or whether it is only possible because of the shadow of state law and enforcement power.

This distinction about the origins of property rights matters because while governments can provide benefits in furnishing public goods and supporting property rights institutions, governments also impose costs through the centralization of power and the implications this has for the centralization of other functions such as money, record keeping and registries. Blockchains reduce opportunism and therefore economise on disorder costs.

6. Creative destruction

Governments also have a role in addressing the effects of creative destruction, or the economic disruption to jobs, firms, industries and ways of doing things in consequence of new technologies. A key way that governments can facilitate the adoption of a new technology is to support or compensate those negatively affected by the technology and to facilitate their adaptation to a new technological regime by complementary investment (e.g. education and retraining) and redistributing resources, for instance brokering compensation and re-structuring displaced resources. Without such government action, including the work of private coalitions such as industry associations, those who expect to be harmed by the adoption of a new technology may form coalitions to seek political redress, seeking to use legislative means to block or substantially raise the private costs of developing the new technology (Juma 2016).

Blockchain technologies face substantial hurdles from incumbents and vested interests with powerful economic incentives to invest in political means (lobbying) to slow or outright ban uses of the technology. Governments may find themselves on both sides of creative destruction, seeking to promote the development and adoption of this new technology for social welfare maximizing reasons, while at the same time being captured by protection seeking vested interests.

From its origin as an anti-government technology, the relation between blockchain and government is complex. Governments find themselves in mutual positions as supporters and opponents of this technology, as well as potentially major users of the technology, much of which will be highly disruptive to its existing operations. But this is also a very new technology with substantial uncertainty associated with its future uses, adoption levels, and properties. In consequence, governments around the world have adopted a range of positions, ranging from ignorance to studied indifference to actively engaged, of which those engaged reactions range between outright hostility to active and enthusiastic support.

Yet it seems likely that blockchain technology will have a significant effect on public policy as the technology is adopted for multiple uses in government, and as government makes significant investments in infrastructure, regulation and legislation. Government adoption of blockchain technology should also be considered beyond the aggregate benefit to citizens, and also considered from the strategic perspective of governments themselves, for whom the civilian adoption of blockchain technology imposes costs (as well as benefits). There are strategic conflicts between governments and citizens that will affect the geography, speed and form of blockchain public policy.

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