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Decentralised finance, regulation, and systems theory

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Abstract

Cryptocurrency has sparked expressions of concern from regulators – though sometimes coupled with expressions of interest in state-backed alternatives. This paradoxical situation neatly encapsulates the conundrum confronting regulators as they seek to come to terms with the new world opened up by blockchain and leading ultimately perhaps to decentralised finance. How do we best understand this confusing situation? This paper looks for answers by attempting to conceptualise the phenomenon of decentralised finance in autopoietic systems terms. Insofar as a plausible argument can be made for the proposition that finance represents an example of the internal differentiation of the economy, does decentralised finance in some sense constitute an *intensified internal differentiation*? Alternatively, and paradoxically, insofar as what we are concerned with is decentralised finance, does it instead in some sense represent an example of *dedifferentiation*? Answers to these questions will have relevance for efforts to regulate this emerging phenomenon. They will also help to shed light on whether state and central bank experiments in this space will produce positive effects or bring their own challenges.

Key words

Cryptocurrency; central bank digital currencies; internal differentiation; dedifferentiation

Resumen

La criptomoneda ha suscitado la preocupación de los reguladores, aunque a veces ha ido acompañada del interés expresado sobre algunas alternativas respaldadas por el Estado. Esta paradójica situación resume a la perfección el enigma al que se enfrentan los reguladores cuando tratan de aceptar el nuevo mundo abierto por la cadena de bloques y que, en última instancia, quizá conduzca a unas finanzas

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descentralizadas. ¿Cuál es la mejor manera de entender esta confusa situación? Este artículo busca respuestas intentando conceptualizar el fenómeno de las finanzas descentralizadas en términos de sistemas autopoiéticos. En la medida en que se puede argumentar de forma plausible que las finanzas representan un ejemplo de la diferenciación interna de la economía, ¿constituyen las finanzas descentralizadas, en cierto sentido, una *diferenciación interna intensificada*? Por otra parte, y paradójicamente, en la medida en que tratamos sobre finanzas descentralizadas, ¿representan en cierto sentido un ejemplo de *desdiferenciación*? Las respuestas a estas preguntas serán relevantes para los esfuerzos por regular este fenómeno emergente. También ayudarán a arrojar luz sobre si los experimentos del Estado y los bancos centrales en este espacio producirán efectos positivos o nuevos desafíos.

Palabras clave

Criptomoneda; monedas digitales de bancos centrales; diferenciación interna; desdiferenciación

Table of contents

1. Introduction

Cryptocurrency – a digital token intended to allow the transfer of value without a financial institution by using a peer-to-peer network (Nakamoto 2008, 1) – has sparked expressions of concern from regulators – though sometimes coupled with expressions of interest in state-backed digital currency alternatives. This paradoxical situation neatly encapsulates the conundrum confronting regulators as they seek to come to terms with the new world opened up by blockchain and other distributed ledger technologies which "generate computational proof of the chronological order of transactions" (Nakamoto 2008, 1). On the one hand, a smart contract – that is, one which takes "the form of computer code on a Distributed Ledger Technology… and *executes itself* upon receipt of electronic data inputs" (Unsworth 2019, 17) – offers advantages of security and efficiency; on the other, it raises the spectre of transactions beyond the reach of regulatory authorities and, thus, prone to misuse for money laundering and tax evasion.

State reactions to cryptocurrency transactions perhaps provide an early insight into the full extent of the challenges now faced. Insofar as such transactions rely on centralised exchanges, regulators have some leverage. But banning cryptocurrency transactions entirely or sanctioning exchanges that offer regulated products without authorisation, simply means that the exchanges might move offshore. And once decentralised finance, which needs no such exchange, is factored in, the potential impotence of traditional regulation is starkly exposed. At the same time, however, states are actively looking to see how they can make effective use of the very same technologies.

How do we best understand this confusing situation? After reviewing recent controversies, this paper looks for answers by attempting to conceptualise the phenomenon of decentralised finance in autopoietic systems terms. It does so, first, by setting out the key elements of the theory that it draws upon; second, by considering blockchain, crypto, and decentralised finance from a systems perspective; third, by revisiting Luhmann's approach to contract in systems terms; before, fourth, conceptualising the relationship between decentralised finance and the economy from a systems perspective – specifically, by drawing upon earlier work that attempted a similar exercise in terms of the relationship between finance and the economy. Insofar as a plausible argument can be made for the proposition that finance represents an example of the internal differentiation of the economy, does decentralised finance in some sense constitute the ultimate *internal differentiation*? Alternatively, and paradoxically, insofar as what we are concerned with is *decentralised* finance, does it instead in some sense represent an example of *dedifferentiation*? The significance of the answers to these questions is then considered, together with the light they shed on the possible outcomes of state and central bank initiatives in this space. Noting that the systems theory approach reveals potentially problematical consequences arising from intensified internal differentiation and dedifferentiation in both private and state uses of the new technologies, a proposal is made which, while not constituting a substantive solution, aims to ensure that the possible difficulties are not lost to view in the inevitable blind spots created by the two systems-inspired theoretical perspectives; this involves the orthogonal juxtaposition of the two alternatives – intensified internal differentiation and dedifferentiation – (that is, simply, placing them at right angles to each other) and thus the mutual exposure of the blind spots. Conclusions are then drawn.

2. Recent controversies

In recent years, it has been impossible to avoid discussions of the emerging Web3 world that depends upon blockchain: the record highs and precipitous falls in cryptocurrency prices prompting efforts to understand "the underlying processes driving the valuation" of cryptocurrencies (Kim *et al.* 2021); concern about the energy required by "proof of work" systems where it has been shown that higher trading volumes lead to higher energy consumption and thus increased effects upon the environment (Schinckus *et al.* 2020) versus the potential benefits of blockchain for sustainability (Wilson 2022); the extraordinary sums paid for non-fungible tokens and the risks for regulators in attempting to define categories for intervention (Karandikar *et al.* 2021); the attractions offered or threats raised by the metaverse (Sonvilla-Weiss 2009); and, at the geopolitical level, the ease with which supporters of Ukraine have been able to transfer funds to that government using bitcoin (Criddle and Oliver 2022), and the ease with which Russian oligarchs have been able to use the same approach to avoid sanctions (OFSI and FCA 2022). It will no doubt only be a matter of time before current perceptions of a benign relationship between artificial intelligence and decentralised finance (Smith 2020) give way to fears that this could constitute a monstrous coupling.

It is relatively easy to find supporters who shrug off the recent travails of the crypto market as an opportunity to separate the strong concepts from the weak. Such enthusiasts remain convinced of the radical possibilities opened by the technology, suggesting that it is not only "a question of facilitating exchanges of value but also of reimagining community participation and 'network governance'" (Kasriel 2022). It is just as easy to find detractors who see the same events as evidence of fundamental flaws that can never be overcome – most strikingly in the letter to Congress from 1,500 concerned scientists (concerned.tech 2022). There is certainly no apparent lack of willingness on the part of regulators to clamp down on crypto. The vice-chair of the US Federal Reserve, for example, has said that "[a]s we work to future-proof our financial stability agenda, it is important to ensure that the regulatory perimeter encompasses crypto finance" (Brainard 2022). The People's Bank of China, the central bank, has already banned all crypto transactions (PBC 2021a). India has hinted at the introduction of legislation, but more recently appears to be signalling that it will wait for an international initiative (Indian Ministry of Finance 2023). At the same time, it is striking to observe that some of the same jurisdictions are enthusiasts for state- or central bank-backed digital payment arrangements. India, for example, launched the Unified Payments Interface in 2016 (NPCI 2016). Brazil has recently unveiled the digital *real* (Banco Central do Brasil – BCB – 2023). China has already launched the e-CNY (PBC 2021b). Do these latter moves signal the onset of a more orderly and consumer-oriented use of the new technologies? Or do they lend support to the views of crypto believers who seek to realise the dream of true decentralised finance outside of state control?

With such divergent views evident and claims from both sides of the argument that the stakes in terms of success or failure are unprecedentedly high, this paper considers how these phenomena might be conceptualised from the perspective of autopoietic systems theory and what such a characterisation might offer in terms of assessing the arguments of the proponents and the critics.

3. Autopoietic systems theory

Systems theory, as developed in the social sciences especially by Niklas Luhmann (1984), understands modern functionally differentiated society as composed of communicative systems that are characterised by their autopoiesis, that is, by their simultaneous cognitive openness and normative or operational closure. In such a society, the systems of politics, economy, law, and science, among others, are understood to have these characteristics. As such, each constructs its own environment on the basis of its own immutable internal binary code (for example, legal/illegal for law, true/false for science, payment/non-payment for economy, etc.) and proceeds via changeable self-steering programmes, understood as minimising the difference between the current direction of travel and the desired one – with both, of course, being internally constructed on the basis of the binary code (Luhmann 1998). The uncompromising nature of the binary code in this theory is particularly manifest in the fact that it inevitably creates a blind spot in each system. The system cannot apply its code to itself without creating a paradox. As such, the survival of each system depends upon its ability to "deparadoxify". Equally, the system cannot "see" what its code does not allow it to "see". Such an understanding of society has profound implications. Gone, for example, is any conception of the simple transfer of information between systems, to be replaced by the idea that information is only ever internally constructed by each system on the basis of its own access to the (internally constructed) environment which is dependent upon its own binary code. Gone, too, therefore, is any easy assumption that regulatory interventions will operate in the way that policymakers, legislators, and regulators routinely assume that they do (Teubner 1985).

Given these observations (inevitably simplified in the context of this brief article) it is not hard to see why this theoretical approach can be perceived to possess an inbuilt pessimism. Its proponents, however, would prefer to speak of its realism and its unwillingness to gloss over the inconvenient truths of modern society. Furthermore, for all that there are those who insist upon the need to restrict oneself to the descriptive potential of Luhmann's insights and criticise any effort to deploy them normatively (e.g., King and Thornhill 2003) (on the grounds that there is an internal contradiction between accepting the inability to predict outcomes in the context of autopoiesis and then attempting to propose solutions that must inevitably fall foul of that same inability), others contend that there is nothing inherently problematical about accepting the limitations imposed by those insights while proposing responses that respect them and thus make no strong claims to certain success (e.g., Teubner 1983, 1992). Thus, even if it is accepted that the mutual normative closure of systems imposes limits on the ability to think in terms of simple information transfer between them, it is possible to suggest that the concept of structural coupling (which occurs when the same event is selected by different systems resulting in "extremely close relationships between system and environment" [Luhmann 1987, 342]) opens up possibilities for institutions and instruments which seek to take advantage of such situations (Paterson and Teubner 1998).

4. Blockchain, crypto and decentralised finance from a systems perspective

How, then, should we characterise these new phenomena from a systems theory perspective? What would such a characterisation tell us? At first glance, the answers could appear deceptively simple. Insofar as they are no more than technologies, it would be possible to conceptualise them straightforwardly as institutions which bind the systems of science and economics in specific ways (Paterson and Teubner 1998). A systems perspective would then focus on the structural coupling thereby achieved and could perhaps begin to make observations about the challenges of regulation, as well as perhaps the opportunities that might exist to design interventions which, while respecting the mutual normative closure of the systems, nevertheless seek to take advantage of the closeness implied by that structural coupling.

The rhetoric of the supporters of these technologies points, however, to something much more significant, with references to radical decentralisation and a shift in the balance of power from governments and corporations to the people. In essence, the claim is that the underpinning blockchain technology offers a future in which the hegemony of the giant corporations that dominate finance and the internet is undermined, and new services may emerge which better reflect the preferences and needs of ordinary people. With regard to government, it is interesting to see Mark Zuckerberg's Meta speaking in terms of "social tokens, community tokens, governance tokens" in the context of a "democratic ownership economy" (Kasriel 2022). It is, of course, not clear what this means – and, to be fair, the proponents would likely baulk at the idea of being able to determine in advance what shape and form these developments might take in the hands of people newly so empowered.

It is also important to acknowledge that others are sceptical about these sorts of claims and seek to remind the enthusiasts of the difficulties involved in dis-embedding crypto from traditional foundations. While blockchain can give the impression of a single technology, the truth is that a number of protocols are in use which are not necessarily compatible or "interoperable", to use the favoured term (Kotey *et al.* 2023). Thus, while it is true that interoperability in the context of blockchain can be seen as an expression of the imperative of decentralisation, it is also true, paradoxically, that the easiest way to ensure interoperability is to have a unified platform and medium of exchange, with the decentralisation occurring at the level of the development of goods and services. In other words, what is being constructed is a virtual market, but a market nonetheless in which there will be a similar desire for rules and regulation and enforcement as exists on any other market. If this analysis is true, then, far from flying free of the shackles of conventional governmental and corporate control, decentralised finance will simply be a somewhat exotic variety of a rather familiar species.

In order to accommodate the most ambitious claims of the enthusiasts while simultaneously taking seriously the possibility that nothing emerges that irretrievably challenges existing governance and regulatory arrangements, the systems theory-inspired approach adopted here begins by considering the most fundamental component of the technologies – the smart contract – and traces its implications for society understood as composed of functionally differentiated social systems.

5. Systems theory and contract

It is instructive to begin by considering what Luhmann has to say about contract generally, writing at a time, of course, before any of the technologies discussed here had even been imagined. For him, the "balance of mutual performance" in any exchange is not in some inevitable sense a matter for the legal system; this is something that the economic system can deal with by itself. But legal problems emerge from the binding reciprocal obligations and in the control of problems arising after conclusion of a contract (Luhmann 2004, 258, note 79). In this sense, the "contract itself takes the place of exchange. It *regulates its own execution*" (Luhmann 2004, 251; emphasis added). This is a most striking formulation, seeming as it does at first sight to prefigure smart contracts.

To determine whether this is really the case, however, it is necessary to pursue Luhmann's analysis further. In this regard, his analysis of enforcement is important, insofar as for him it depends ultimately on the exercise of *political* power (Luhmann 2004). This has a number of implications for the evolution of contract as both a legal and an economic entity. First, it implies that there is in principle a (potentially large) degree of freedom with regard to the content of any contract in a functionally differentiated society; insofar as any particular issue is not expressly categorised as unlawful, it may be the subject of a contract. Second, it implies that the private sector is offered the opportunity to test how far it can go in influencing the exercise of political power; by investing a private transaction with legal significance, the private sector can influence politics insofar as the latter may ultimately be called upon to sanction enforcement. The corollary of that last observation, however, is that it creates an opportunity for politics to set limits on what may be privately transacted insofar as it may decline to sanction enforcement in the context of certain categories of contracts.

Much therefore depends, firstly, upon the courts' willingness to invest a contested private bargain with legality, such that enforcement becomes a possibility, and, secondly, upon politics' willingness to deploy power to sanction such enforcement. The development of crypto transactions based on blockchain thus appears as a private sector initiative to invest these particular forms of exchange with legal significance which, when they require to be enforced, may be met with either a sympathetic hearing in court, insofar as politics has not outlawed such transactions, or a closed door, insofar as politics has taken the opposite view.

But is this analysis not too simplistic? The distinguishing feature of the smart contract is surely precisely that it does not depend upon the architecture of the legal and political systems but can operate purely within the economy. This is where precision is important. The smart contract, being self-executing, essentially obviates the need to rely on political power in the way that a normal contract does. Whereas for Luhmann, the contract represents an evolution from simple exchange because it *regulates* its own execution, the smart contract may be said to constitute a further evolutionary step insofar as it *executes itself* – a very different thing. This indicates the extent to which decentralised finance, built upon smart contracts, seeks to avoid the reach of politics and even of law insofar as (1) the relevant contracts are self-executing, and, as a consequence, (2) trust and governance do not depend on central institutions, courts and political power.

With these observations in mind, it is a question then of how decentralised finance might appropriately be characterised in systems theory terms. In order to answer this question,

it is necessary first of all to recall how in earlier work (Paterson 2013) the evolution of financially engineered products or derivative financial instruments was analysed in this regard.

6. The relationship of finance to the economy in systems theory terms

Derivative financial instruments (such as credit default swaps) exist, first and foremost, simply to allow their purchasers to hedge risk (in this case, because they are exposed to credit risk associated with the purchase of corporate bonds). What appears simple at first glance, however, becomes more complex when it becomes clear that (1) the seller of the instrument thereby increases their own risk, and (2) the nature of such instruments means that an inappropriate purchasing policy can actually increase the risk for the party whose intention was to hedge it. Furthermore, the seller of the instrument in turn hedges their risk by purchasing another more complex financial instrument from a seller who in turn thereby takes on a risk that requires to be hedged. In addition, the market for such instruments exists only to the extent that the relatively small number of risk-hedgers are joined by a relatively larger number of speculators to provide liquidity. The presence of the speculators, however, only increases risk. Finally, the nature and scale of these markets is such that when risks crystallise, they need not only engage the immediate parties to specific transactions but can also manifest themselves as systemic risks.

How is the paradox of risk-reduction by the creation of risk managed? The previous work (Paterson 2013) looked at the possibility of the internal differentiation of the economic system to explain the emergence, persistence and indeed expansion of financial markets. This work considered some of the derivative financial instruments that were implicated in the global financial crisis of 2008, specifically credit default swaps (and the related "real economy" instruments: corporate bonds). The approach there was to utilise the insights of systems theory to gain a richer understanding of these instruments in the context of the fragmentation of contract as opposed to the popular perception of contract as a unity – and indeed as a unifying instrument (Teubner 2000, 2007). Instead of a simple focus on the instrument itself, there is an appreciation of its multiple existences within a variety of discourses – economic, productive, and legal – where it is involved in a variety of transformations – economic, productive, and legal. Despite these multiple existences, however, the contract is also seen as a means by which structural coupling—the "twofold membership of events" in different systems (Luhmann 1987, 342)—can occur (Teubner 2007, 54).

Whereas, on one hand, corporate bonds analysed in this way revealed the interplay of law, economy, and a productive system (for example, science), on the other, credit default swaps revealed a more complex picture: the interplay of law and economy, but without the involvement of any productive system. Rather, in the context of such swaps, there appeared to be *two* economic constructions of the contract: one focused on risk-reduction and the other on the amplification of payments. The question was then how to account for this in systems theory terms? There appeared to be three possibilities:

a) There is a separate system of finance, distinct from the system of the economy, or

b) different *organisational* systems (for example, corporations, trusts, etc.) are able to make simultaneous use of different economic steering programmes, or

c) finance is an internally differentiated subsystem of the economy.

It was easiest to rule out the first possibility: it is evident that the same binary code – payment/non-payment – is being used in both "real" economic transactions and in financial market transactions and thus that only one autopoietic system – economy – is in play. The second possibility looked more promising. As was seen above, while the system's code is invariable, different steering programmes are possible (Luhmann 1998). Accepting that possibility did not, however, rule out the third one and might even be dependent upon it. Furthermore, when Luhmann's account of the process of internal differentiation was factored in, the third possibility looked, if anything, the most promising.

In Luhmann's account, "[i]nternal differentiation connects onto the boundaries of the already-differentiated system and treats the bounded domain as a special environment in which further systems can be formed". This observation leads to four important consequences: firstly, insofar as a functionally differentiated autopoietic system's internal environment manifests its specialised reduction of complexity, any process of *internal* differentiation can evolve on the basis that "certain capacities for regulation" are presupposed; this in turn provides a platform for "[n]ew, more improbable system formation"; thirdly, given the improbability of any such new internal system formation, it can only survive insofar as it "can mobilize processes of deviation-amplification (positive feedback) to [its] own advantage and keep [itself] from being levelled out again"; finally, Luhmann stresses the extent to which the dependence of internal differentiation upon the system boundary serves to reinforce that boundary (Luhmann 1996, 189-90).

Taking each of these points from Luhmann in turn and considering them in the light of the suggestion that finance is an internally differentiated system of the economy, the following picture was offered. Firstly, economy's pre-existing reduction of complexity through its payment/non-payment binary code provides any process of new internal system formation with a greatly simplified account of the environment on which to operate. Secondly, the improbability of the emergence of the subsystem of finance is perfectly characterised by the extent to which a considerable number of derivative financial transactions depends upon a relatively small number of economic transactions. Thirdly, despite this improbability, finance, as an internally differentiated subsystem of the economy, can sustain itself and prevent its dissolution by successfully mobilizing positive feedback to its own advantage: in particular it offers simultaneous enhancements in terms both of payments and of risk-minimisation. Finally, the dependence of finance as such an internally differentiated subsystem upon the system boundary established by the economy means that that latter boundary is itself reinforced. Were any evidence required of the success of finance in this regard, it is necessary only to consider how much of every other system, whether communicative or living, has been commoditised – a process, of course, which shows no sign of abating.

This analysis of derivative financial contracts appeared to reveal the extent to which the fragmentation of contracts in the context of autopoietic systems could lead to problems.

It also raised the question of whether there were any obvious means by which the problems could be mitigated. The answers, however, were not encouraging. Firstly, any effort to overcome the fragmentation in the context of organisations must face the realisation that system boundaries are not thereby overcome even if systems are brought into closer contact – indeed, the presence of the organisation adds another boundary. Secondly, the limits of any regulatory effort are starkly exposed in the context of autopoiesis, even those seeking to make use of economic incentives – indeed, perhaps especially those.

7. The relationship of decentralised finance to the economy in systems theory terms

Matters appear both more simple and more complex when the move is made from the example of derivative financial instruments to that of decentralised finance. Firstly, the issue of the fragmentation of contract does not appear so acute. Indeed, it could be argued that the proponents of smart contracts would explicitly claim that the unity of the smart contract is not apparent but real. In this sense, it might be suggested that decentralised finance is more radical even than financial engineering, representing perhaps the fullest expression of the extent to which private ordering can maintain its autonomy from politics. Insofar as this is accurate, decentralised finance looks like an effort to utilise specific technologies to enable contracts that do not depend on either the legal or the political system. In essence, then, this could constitute an effort to carve out a separate parallel order within the economy and one that represents a much more intense internal differentiation of the economy than was observed even with derivative financial instruments.

If the prospects for the regulation of such instruments in the context of an autopoietic understanding were limited, how much more so might that be the case with decentralised finance understood as an even more complete case of internal differentiation? But perhaps this is to look at the emergence of this phenomenon in the wrong way. After all, for Luhmann, "systems in advanced societies justify themselves by the extent to which they *differentiate* themselves from other systems, not by the degree to which they *regulate* them" (Luhmann 2004, 97-8; emphasis added). In other words, modern functionally differentiated society is characterised by a high degree of both external and internal differentiation, so that in and of itself a high degree of internal differentiation need not give rise to concern. And yet insofar as the concern in the context of decentralised finance does not seem misplaced, what is the cause?

The answer may lie in a shift in perspective. Instead of focusing on the extent to which decentralised finance represents as an effort to insulate the operations of the economy from the influence of law and of politics, might it be instructive to focus on the extent to which that effort could be read as a blurring of the lines between economy, politics, and law? In other words, what is in play is not (or not only) a radical internal differentiation of the economy, but rather (or also) an example of *dedifferentiation*. Given that intense internal differentiation appears to cause concern, it might be felt that its very opposite should be warmly welcomed, but here it is necessary to be careful about what is wished for. If modern society is characterised by its degree of functional differentiation, then one has to consider the extent to which any move in the opposite direction should

automatically be seen as positive. Are there circumstances, for example, in which such a move might result in a society with elements of pre-modernity that might be substantially at odds with modern conceptions of human rights?

Whatever the concerns that might accompany any dedifferentiation, however, there is clearly prima facie merit in the proposal that developments associated with decentralised finance may indeed manifest such characteristics. Nevertheless, this fact creates a paradoxical situation: the result of the analysis based on the insights of autopoietic systems theory appears to be that the same evolution of the economy in the shape of decentralised finance based on smart contracts displays diametrically different characteristics of both internal differentiation and dedifferentiation depending upon whether one sees the effort to avoid dependence upon politics and law principally as an intensification of financial operations or as a blurring of the lines between economy and other social systems.

This in turn leads to another unexpected observation. Whereas systems theory traditionally has been concerned with the problems raised by the fragmentation of contracts (which must be understood to have separate existences in the various relevant systems), it now appears that *smart* contracts present a different order of fragmentation insofar as they manifest characteristics of both internal differentiation *and* dedifferentiation. The question then is what sort of response might be envisaged to such a complex situation. "Old" ideas based on structural coupling would appear to go only so far in such circumstances – and indeed maybe not very far at all. In the next section, consequently, consideration will be given to whether Gunther Teubner's observations on a possible response to the fragmentation of contract could be adapted to this novel situation.

8. Juxtaposing internal differentiation and dedifferentiation

When autopoietic systems theory has been deployed to analyse traditional contracts, it has revealed, as discussed above, first, the extent to which they are inevitably fragmented among the systems of law, economics and whichever productive system is in play and, second, that there is no room for them to operate as a unifying force beyond the limited role of structural coupling. This has meant that the only hope for the reappearance of any such unitary model of the contract will be in the context of *another* theory, complementary to systems theory, which could, as it were, illuminate the blind spot of functional differentiation and focus on the binding force of contracts that autopoiesis cannot see (Teubner 2007, 63).

Such a step does not imply that the fragmentation of the contract is somehow miraculously cured. What is aimed for here is no more than the generation of a "surplus value" by the orthogonal positioning of these two complementary theories (that is, as mentioned in the introduction, placing them at right angles to each other) for the mutual illumination of blind spots. In other words, whereas autopoiesis exposes the fragmentation of contract that is masked by the unifying assumptions of traditional theories, such a theory can expose the unifying role of contract that is masked by the insistence of autopoiesis upon the operational closure of the social systems involved in any contract. That surplus value is not a magic bullet, however—it is no more than an indication of the direction in which some alleviation of the detrimental effects of the

fragmentation of contracts might lie, in the same way that it is equally an indication of the limitations imposed by a unifying theory on an adequately complex understanding of contract in a functionally differentiated society.

It is important to recognise, however, that the fragmentation Teubner identifies is not in some sense neutral; rather it results in an opportunity for one system, the economy, to dominate. The specific form of this dominance in the context of autopoiesis is the market's monopolisation of "the right to interdiscursive translation" and thus the imposition of the "economic translation on the other discourses" (Teubner 2007, 67). He thus proposes a "new freedom of contract", one which "would destroy the project of an economic rationalization of the world and introduce the obligation of a necessary and simultaneously impossible translation amongst the different languages of the social world" (Teubner 2007, 68). Putting this idea of "contract as translation" into effect would require "an extension of constitutional rights into the context of private governance regimes", something, however, that Teubner realises would require a "fundamental rethinking of the horizontal effect of constitutional rights" (Teubner 2007, 71).

The immediate question, however, is whether what is involved in smart contracts and decentralised finance is adequately captured by the "economic rationalisation of the world" and the claimed "right to interdiscursive translation". From the earlier analysis, it would appear not. What is at stake here is not so much domination by the economic discourse as, first, in the internal differentiation dimension, an effort to aggregate the functions of law and politics to the economy in the context of the smart contract – a much more ambitious project – and, second, in the dedifferentiation dimension, a new fusion of the economy with other social systems – a much more destructive project. As dramatic as these observations are, manifesting a potentially much more troubling picture than the "mere" fragmentation of contract, it is not necessarily the case that Teubner's prescription of juxtaposing competing theories to illuminate their respective blind spots is of no avail in this new context.

To see how far Teubner's insight might go, it is possible to begin by focusing on the first dimension identified by the systems theory characterisation of the new technologies. That analysis, revealing the status of decentralised finance as, in one dimension, an intensely internally differentiated subsystem of the economy, would appear to reinforce Teubner's conclusions on fragmentation. It is no longer simply that contract is split between "the triangle of contractual projects" (Teubner 2007, 70), that is, between law, economy, and a productive system, but rather that it is further split – and quite radically, albeit internally – between economy and finance. Thus, while in the context of decentralised financial contracts there is at first sight a reduction of the fragmentation insofar as an effort is made to do away with the need for law and politics, closer analysis reveals that what is important is the *intensification* of the fragmentation. The fact that the fragmentation takes place also within an internally-differentiated subsystem serves to reinforce the degree of separation of that construction of the contract from others—and, as a by-product, to reinforce the differentiation of the economy itself.

So much for the diagnosis in relation to internal differentiation, but what about the prescription? At first sight, it could be suggested that support for Teubner's prescription of contract as translation, of a constitutionalisation of contract, is hard to find. There is no argument at the conceptual level, but the empirical domain of decentralised finance

reveals the scale of the challenge facing a complementary theory which would purport to illuminate system theory's blindness to the unitary and unifying nature of contract. Thus, the same intensification of fragmentation that supports Teubner's diagnosis places obstacles in the path of his prescription. It would thus appear that the surplus value that would need to be generated by the orthogonal juxtaposition of the theory of contractual fragmentation and a theory of contractual unity to produce any meaningful outcome would have to cross a very high threshold indeed.

The threshold is so high precisely because of the intensification of the fragmentation that decentralised finance as an internally differentiated subsystem is able to achieve. By seeking to aggregate the functions of law and politics to the economy, it purports to intensify the hegemony of the economic discourse and thus to render the need for contract as translation all the more necessary and yet, simultaneously, all the more difficult to achieve. Consequently, if the new map of the landscape produced by a systems theory analysis does not question the direction in which we have been pointed by Teubner's idea of contract as translation, of the constitutionalisation of contract, it does nevertheless reveal that the journey would be longer and more arduous in the context of decentralised finance.

So far, of course, the focus has been on the extent to which the analysis in the earlier part of this paper confirms Teubner's views on the fragmentation of contract, albeit in a new, perhaps unexpected, and certainly intensified variety. What has not yet been added to the mix is the paradoxical *dedifferentiation* that is simultaneously displayed by decentralised finance. And, indeed, it may appear to be a tall order to accommodate it in an arrangement which did not in any way have such a possibility in mind. A theory of contract as translation looks to be struggling for a foothold in the dizzying prospect of simultaneous fragmentation and dedifferentiation now opened before it. It is precisely here, however, that it may be necessary to turn away from the seductive safety of such a unifying option and embrace the danger that the current analysis reveals. In other words, it is not so much a question of looking first and foremost for a solution to fragmentation and/or dedifferentiation as of ensuring that there is at the outset a broadscale acceptance of the paradoxical and destructive (or least disruptive) potential of decentralised finance. In this sense, the first task is to achieve the orthogonal juxtaposition of a theory of fragmentation (which implies the ongoing autopoietic integrity of the systems in play) with a theory of dedifferentiation (which implies that that integrity is under threat). The result of such a step would be to expose the blind spot of each perspective and hence the potential pitfalls of an unquestioning acceptance of the allures of decentralised finance. The supposed efficiencies and democratising effects of decentralised finance would take on a new light when understood (albeit sequentially rather than simultaneously) as a problematic aggregation of the functions of law and politics to the economy and a worrying blurring of the lines between economy and other social systems.

9. Where next?

But where might such an approach take us? Teubner uses the wave-particle analogy from quantum physics to illustrate what emerges from the orthogonal juxtaposition of complementary theoretical pictures. We should not be surprised, then, if the insights of this sort of orthogonal juxtaposition in the current context do not immediately resolve

themselves, but perhaps emerge only as we leave the mutual exposure of blind spots to play out as it will, both at the level of scientific analysis and at the level of practice in the realm of decentralised finance.

There is no suggestion that the simple orthogonal juxtaposition of the alternative existences of decentralised finance will produce some remarkable hybrid that miraculously avoids the risks inherent in each, but it might provide a rare platform for careful consideration of the paradoxical co-existence of such diametrically opposed tendencies in the context of the same technology. Consequently, despite the challenges, one might nevertheless hope for outcomes that seek to avoid the problems that could emerge were either problematic tendency (intensified internal differentiation or dedifferentiation) to begin to assert itself.

It is important to stress that the approach proposed here does not claim some privileged access to reality which somehow escapes the limitations of the internal differentiation and dedifferentiation perspectives. Inspired by autopoietic systems theory, there is no suggestion that it is possible to avoid a blind spot. Even the selection of the two perspectives as orthogonal complements constitutes a dividing of the unmarked space (Spencer Brown 1972) and, therefore, the inevitable creation of a further blind spot. Insofar as that is true, the vertiginous prospect of an infinite regress opens up, which can only be avoided by pretending that the blind spot does not exist. That looks paradoxical, given that this particular division of the unmarked space was effected precisely to produce a mutual exposure of blind spots, but systems theorists are undeterred by paradox and the inevitable need to adopt deparadoxification strategies.

10. But is there really a problem?

A key observation of the last couple of years, every bit as striking as the problems facing crypto, has been the extent to which states, central banks, and other actors from the world of traditional finance have themselves embraced digital payment technologies, as was mentioned earlier. Against the decentralising instincts and efforts of the crypto enthusiasts, this looks to be evidence of the resilience of the state in the face of the challenge.

This development is, however, not homogenous, nor is it without controversy. At one level, as in India or Brazil, this can represent a generally benign effort on the part of the state to bring into the economy individuals who currently lack bank accounts and thus access to other financial products, so offering them opportunities they otherwise would not have. This in turn can promote growth and indeed make it more likely that more people will pay income tax, thus strengthening the connection between government and governed and, all else equal, enhancing the democratic credentials of the polity. In autopoietic systems terms, therefore, the use of smart contracts for payments may be understood as a structural coupling between economy and politics, with the latter seeking to ensure (albeit not inevitably) that economic benefits accrue to those whom the market might not otherwise recognise. There are, of course, no guarantees, but the fact that the desired outcome may be described as procedural or facilitative rather than substantive may be significant. In other words, politics through such an initiative does not seek to determine specific transactions or the outcome of any transactions, but rather

only to ensure that individuals have the ability to engage in a broader range of transactions than they would otherwise have access to.

At another level, however, as in China, this state-backed enthusiasm for the new payment technologies can represent an effort on the part of government to gain an unrestricted view of the entirety of every individual's and every business organisation's payment transactions. This in turn can mean that the tools of financial digitalisation are subordinated to the authoritarian purposes of the state, not least because the same technologies can be deployed seamlessly to withhold benefits (and, indeed, rights) as a penalty for behaviours deemed unacceptable. In autopoietic systems terms, therefore, the use of financial digitalisation technologies to enhance the abilities of the surveillance state may be understood as the dedifferentiation of politics and law. Against all expectations and against the hegemonic tendencies of the economy observable elsewhere, the insertion of politics into the heart of every transaction represents an extraordinary unwinding of the progressive functional differentiation of the economy in a country like China since the market reforms of the 1980s (Vogel 2011).

Paradoxically, then, as these diametrically different examples show, the advent of blockchain and smart contracts in the context of payments may not be having the effect intended by the originators and supporters of crypto and decentralised finance. Instead, from a systems perspective, the development has been reconstructed by politics both as an opportunity and a threat, with different outcomes depending on the start conditions. Irrespective of the democratic or the authoritarian character of any particular government, there has been a general move to control and even ban crypto, which, frustratingly for its enthusiasts, it is not easy to circumvent. Where the government is democratic, the technology presents an opportunity to curry favour with newly economically empowered voters and thus a means of retaining power. The other side of that coin, however, albeit a longer-term prospect, is that a greater number of now wealthier voters will pay income tax and thus have a direct stake in the performance of government as well as an opportunity to oust the incumbent. Where the government is authoritarian, however, the technology presents an opportunity to monitor and control payments to an unprecedented degree, thus bucking the trend of the hegemonic expansion of the economy and replacing it with the hegemonic expansion of politics. Thus, to answer the question posed at the outset of this section, there is not always a problem of the sort identified in the foregoing section where the successful achievement of decentralised finance by the private sector results in the paradoxical simultaneous intensified internal differentiation of the economy and the dedifferentiation of economy and other social systems; on the other hand, where the state deploys the same technologies, the possibility of other problems, specifically the dedifferentiation of politics and other social systems, then emerges.

11. Conclusion

The foregoing argument has certainly considered what autopoietic systems theory may reveal about decentralised finance were its ambitions ever to be realised. It has also considered what a similar perspective may reveal about state-backed initiatives to take advantage of the same technologies. To that extent, the promise of the admittedly rather open-ended title of this article has been fulfilled. But what about regulation? It has certainly been mentioned in passing, but usually in ways that remind us about the limits

imposed by the autopoiesis of social systems on traditional models of regulation which depend upon the straightforward transfer of information from policymaker to legislator to regulator to regulated, and thus upon linear relations of cause and effect. Is it the case, therefore, that the findings of intensified internal differentiation and of dedifferentiation lead to a simple but not unexpected conclusion in relation to regulation that in the face of such complexity regulatory interventions will confront unprecedented challenges? The answer is both *yes* and *no*.

Yes, understanding smart contracts in this setting as an effort to aggregate the functions of politics and law to the economy, thus leading to an intensified internal differentiation of finance within this system, will make traditional regulatory interventions even more difficult. *Yes*, examples of dedifferentiation, whether the result of successful private sector initiatives to decentralise finance, thus blurring the distinction between economy and other social systems, or of governmental initiatives to instrumentalise digital payments technologies to enhance authoritarian oversight and intervention, thus blurring the distinction between politics and other social systems, will compel a rethinking of the role of law.

But also *no*, in the sense that such potentially dramatic outcomes do not inevitably leave law as an increasingly irrelevant observer of social upheaval. Indeed, the new role for law in this setting will depend precisely upon its abilities as an observer. Confronted even with the comparatively "simple" challenges raised for regulation by the autopoiesis of social systems, the advice (by no means uncontroversial) for law has been to examine the opportunities opened by second-order observation, that is, to observe how other systems observe and to modulate "interventions" accordingly, always recognising the limits imposed, first, by law's own blind spot and, second, by the inevitable reconstruction of law's efforts by the "regulated" system. Confronted with the comparatively more complex challenges raised for regulation by the various intensified internal differentiation and dedifferentiation scenarios identified in this study, the advice for law is to shift the focus where appropriate from the relatively simple level of second-order observation to the more challenging (but potentially more important) level of the observation of the blind spots exposed by the orthogonal juxtaposition of two dimensions of systems theory: one characterised by the intensified internal differentiation of finance within the economy; the other characterised by the blurring of boundaries between economy, politics, and other social systems.

Precisely what such an exercise will reveal and precisely what use may be made of law's consequent observations is impossible to foresee. The purpose of this paper has not been to draw firm conclusions about the likely substantive effects of the working out of private or public sector deployments of these new technologies. Rather it has been to contribute to ensuring that an adequately complex picture of these developments is available, and that there is a sense of the direction in which law's efforts in this context, whatever form they ultimately take, might best be deployed.

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