

THE CHALLENGE OF TECHNOLOGY-BASED DECENTRALIZATION TO THE TRADITIONAL LEGAL PARADIGM

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This chapter explores the core challenge that blockchain-based decentralization presents to traditional legal frameworks. Legal systems rely on the identification of subjects – whether natural persons, legal entities, or State authorities – to whom rights, obligations, and consequences can be assigned. This principle of attribution is foundational to nearly every facet of law, including criminal responsibility, contractual obligations, property rights, and regulatory enforcement. However, blockchain technology and autonomous decentralized systems fundamentally undermine this assumption by operating without identifiable centres of accountable authority. Decentralized Autonomous Organisations and Decentralized Finance protocols function autonomously, transcending territorial boundaries and human intermediaries, yet they typically fall under State jurisdictional structures. The argument is made that the fundamental operations of law – determining applicable rules, adjudicating disputes, and enforcing judgments – are predicated on the existence of ‘centres of attribution.’ This situation creates a fundamental tension between the aspirations of decentralization and the operational requirements of law, raising the question of whether the challenges posed by Blockchain can be reconciled with the essential principles of legal order.

Keywords: *blockchain technology, decentralization, smart contracts, legal accountability, jurisdiction, lex cryptographia, DAO, constitutional law, regulatory frameworks, legal personality.*

1. *The Decentralization Dilemma: Reconciling Distributed Ledger Technology with ‘Legal Order’*

Traditional legal order depends fundamentally on the ability to identify subjects – whether natural persons, legal entities, or State authorities – to whom legal consequences can be attributed. This architectural principle underlies virtually every aspect of law: from criminal responsibility to contractual obligations, from property rights to regulatory enforcement, from territorial jurisdiction to legal personality.

Blockchain technology and decentralized autonomous systems challenge this foundational assumption by operating without identifiable centres or responsible authorities. These systems promise to create legal frameworks that function

autonomously, without territorial boundaries, human intermediaries, or the institutional structures that have historically guaranteed legal certainty and enforcement. *Decentralized Autonomous Organisations* (DAOs) make collective decisions through smart contracts and token voting – cryptocurrencies transfer value without banks. *Decentralized finance* (DeFi) provides financial services without the need for licensed institutions. In each case, the system operates – or aspires to operate – without centres to which traditional legal attribution can attach.

This resistance to centres of attribution is not incidental but constitutive: decentralization means the absence of identifiable controlling authorities. Nevertheless, law's basic operations – determining applicable rules, adjudicating disputes, enforcing judgments, allocating responsibility – presuppose the existence of such centres. This creates a fundamental tension, perhaps even an incompatibility, between decentralization's aspirations and law's operational requirements.

How does technology-based decentralization challenge traditional legal paradigms, and can these challenges be reconciled with the law's foundational requirements? More specifically, it examines whether legal systems can adapt their attribution mechanisms to accommodate genuinely centreless systems, or whether ostensibly decentralized systems must ultimately establish identifiable centres to achieve legal recognition and enforceability.

As mentioned above, the analysis employs the concept of 'centres of attribution' (*Zurechnungssubjekt*, as defined in Kelsen's terminology) as an organising framework.¹ Based on Kelsen's pure theory of law and Romano's institutional theory,² it could be argued that law operates solely by attributing rights, duties, and legal consequences to specific subjects. These attribution operations take place across three essential dimensions: the first being territory, which refers to the spatial dimension that anchors jurisdiction and enforcement. Another dimension is language, which serves as the symbolic medium for the articulation and interpretation of norms. Lastly, there is the body, which encompasses the embodied subjects that possess legal personality and experience legal consequences.

Decentralization challenges each of these dimensions while simultaneously revealing their enduring necessity. This framework aims to facilitate a systematic analysis of the legal challenges posed by blockchain technology and provides a cohesive theoretical lens for understanding seemingly disparate issues. The essay employs doctrinal legal analysis supplemented by engagement with legal theory and empirical observation of blockchain systems. It examines how decentralization disrupts traditional legal concepts, evaluates regulatory responses, and assesses normative claims

¹ This concept derives from continental legal theory, particularly Hans Kelsen's. See Hans Kelsen, *General Theory of Law and State* (Harvard University Press 1945) 93. For a contemporary application to digital entities, see Gunther Teubner, 'Rights of Non-Humans?' (2006) 33 *Journal of Law and Society* 497.

² Giulio Itzcovich, "'Something More Lively and Animated Than the Law': Institutionalism and Formalism in Santi Romano's Jurisprudence' (2020) 33 *Ratio Juris* 241, 244, <<https://doi.org/10.1111/raju.12291>>.

about constitutional benefits and conflicts. The analysis moves from the fundamental theoretical challenges that decentralization poses to law generally, rather than examining sector-specific applications in detail. While it references particular contexts (financial regulation, corporate governance, dispute resolution), the analysis aims for generality across applications. So, it concentrates on ‘public’ permissionless blockchains rather than private permissioned systems, as the former present the starkest challenges to traditional legal assumptions. Geographically, the analysis primarily draws on European Union and US legal frameworks, while acknowledging that blockchain operates globally.

2. Law Without Centres: The Decentralization Challenge

The rise of decentralized technologies, particularly blockchain with the support of smart contracts, presents a profound and multifaceted challenge to the traditional legal paradigm, which is fundamentally built upon centralized institutions, territorial sovereignty, human interpretation, and established frameworks for accountability and liability.³ The conflict lies in the core principles of decentralization, (pseudo)anonymity, and automation inherent in these technologies, which range from clashing directly with classic juridical standards concerning stability, liability, territory, and social order; to rarely exploring possible alliances with the law to achieve common objectives. The challenges posed by decentralization applications can be examined across several critical areas: the very symbolic foundations of law, the role and sovereignty of the State, the feasibility of enforcement and jurisdiction, and the applicability of traditional liability and regulatory frameworks.

2.1. Displacement of Foundational Legal Symbolics and Imaginaries⁴

2.1.1. Lex Cryptographia: Nomen aut Res?

Blockchain technology, through its underlying ideology and technical architecture, initiates a potentially profound displacement of the symbolic and imaginary foundations upon which traditional legal systems have historically relied.

³ Katrin Becker, ‘Blockchain Matters – Lex Cryptographia and the Displacement of Legal Symbolics and Imaginaries’ (2022) 33(2) *Law and Critique* 113 <<https://doi.org/10.1007/s10978-021-09317-8>>; Benedetta Cappiello and Gherardo Carullo, ‘Introduction: The Challenges and Opportunities of Blockchain Technologies’, and Tony Lai, ‘Blockchain, Law and Governance: General Conclusion’, both in Benedetta Cappiello and Gherardo Carullo (eds), *Blockchain, Law and Governance*, (Springer International Publishing 2021) <https://doi.org/10.1007/978-3-030-52722-8_1>; 290ff, <https://doi.org/10.1007/978-3-030-52722-8_21>; Francisco Pereira Coutinho and others (eds), *Blockchain and the Law: Dogmatics and Dynamics* (Information Technology and Law Series, T.M.C. Asser Press 2024) 37, <<https://doi.org/10.1007/978-94-6265-579-9>>.

⁴ It is appropriate here to utilise the apt title of the contribution by Becker, ‘Blockchain Matters – Lex Cryptographia and the Displacement of Legal Symbolics and Imaginaries’.

This emerging framework, often termed *lex cryptographia*,⁵ aspires to emancipate itself from three essential dimensions that have characterised modern legal systems: language, territory, and embodied legal subjectivity. However, whether *lex cryptographia* constitutes an alternative form of law or rather a novel regulatory tool operating *within* existing legal frameworks remains a contested question.⁶

On one hand, blockchain-based governance exhibits law-like functions – coordinating behaviour, algorithmically resolving disputes, and enforcing compliance through cryptographic constraints – indicating a functional equivalence with traditional legal systems. On the other hand, its reliance on territorial law for ultimate legitimation and enforcement, its lack of interpretive flexibility and institutional structure, and its operation primarily through technical architecture rather than normative authority suggest that it may be more accurately viewed as one regulatory modality among others,⁷ serving to complement rather than displace State law.

This ambiguity extends beyond mere semantics and carries significant normative implications: to characterise blockchain as ‘law’ may grant it undeserved legitimacy and obscure the private interests embedded within ostensibly neutral technical systems, whereas denying its legal character could close our eyes to genuine innovations in governance and the rise of alternative sources of normative authority. Whether this reflects a completed transformation of law or an ongoing contestation between different regulatory modalities remains an open question that warrants critical examination.

2.1.2. *Language as Symbolic Attribution, Code as Performative Inscription*

Natural language provides the law’s symbolic medium, enabling the articulation of general norms, their interpretation in specific cases, and the communication of legal meanings across time and contexts.

The most immediate consideration is that traditional law has fundamentally relied on natural language as its primary medium, which is inherently characterised by ambiguity, contextual sensitivity, and opportunities for interpretive flexibility.⁸

⁵ The term ‘*lex cryptographia*’ was coined by Primavera De Filippi and Aaron Wright in their 2015 article entitled ‘Decentralized Blockchain Technology and the Rise of Lex Cryptographia’. Subsequently changed to ‘*lex cryptographica*’ in their 2018 book *Blockchain and the Law: The Rule of Code*, the term is employed with a high degree of frequency in the context of academic literature, wherein it refers to a system of rules administered through self-executing smart contracts and decentralized autonomous organisations based on blockchain technology. The concept has been influenced by notions such as *lex mercatoria* and *lex informatica* and it refers to the emergence of a novel legal order that is based on cryptographic code as opposed to traditional legal institutions.

⁶ Stephane Blemus, ‘Law and Blockchain: A Legal Perspective on Current Regulatory Trends Worldwide’ (2018) SSRN <<https://doi.org/10.2139/ssrn.3080639>>. In his paper, Blemus uses the theory of legal pluralism to analyse *lex cryptographia* and argues that it can be seen as a new, autonomous legal order, but one that inevitably ‘competes or cohabits’ with State law.

⁷ See Lawrence Lessig, *Code: Version 2.0* (2nd edn, Basic Books 2006) 120ff.

⁸ Herbert Lionel Adolphus Hart and Leslie Green, *The Concept of Law* (3rd edn, Clarendon Law Series, Oxford University Press 2012) 152ff; Stanley Eugene Fish, *Doing What Comes Naturally*:

Lex cryptography aspires to revolutionise this paradigm by substituting linguistic articulation with computer code as the foundational substrate of legal systems. Proponents argue that this shift promises to eliminate subjective interpretation: legal frameworks such as smart contracts purportedly operate according to rigid ‘if-then’ logical principles that would adhere to the rule of noncontradiction.⁹

However, this vision of code as determinate and interpretation-free warrants critical scrutiny. As legal scholars have observed, code itself requires interpretation at multiple levels. During its creation, when ambiguities in requirements must be resolved; during execution, when edge cases arise; and during disputes, when questions of intent, error, and enforceability emerge.¹⁰ The notorious collapse of The DAO in 2016, which required human intervention and contentious debate despite operating through ostensibly autonomous code, illustrates the persistence of interpretive questions even within blockchain systems.¹¹

Furthermore, this framework embodies what might be termed an anti-representational logic. By attempting to collapse the distinction between word and action within the algorithm, the system seeks to eliminate the deliberative space that characterises traditional legal structures – the gap between norm and enforcement that permits negotiation, proportionality, and equitable adjustment.¹² While proponents

Change, Rhetoric, and the Practice of Theory in Literary and Legal Studies (Post-Contemporary Interventions, Duke University Press 1989) 87ff.

⁹ Massimo Doria and others, ‘Caratteristiche degli Smart Contracts’ (July 2024) Banca d’Italia 26ff.

¹⁰ James Grimmelman, ‘All Smart Contracts Are Ambiguous’ (2021) 2, 1 Journal of Law & Innovation 3, <<https://scholarship.law.upenn.edu/jli/vol2/iss1/1>> accessed 8 February 2026; Lauren Henry Scholz, ‘Algorithmic Contracts’ (2017) 20 Stanford Technology Law Review 128, 136, <<https://ir.law.fsu.edu/articles/607>> accessed 8 February 2026.

¹¹ Quinn DuPont, ‘Experiments in algorithmic governance’ in Malcolm Campbell-Verduyn (ed), *Bitcoin and Beyond* (Routledge 2017) 157ff. The event sparked intense debate about whether the hacker was culpable or had simply exploited code as written – the ‘code is law’ position – thereby shifting blame to those who failed to properly write and audit the smart contract. This ‘social-technological norm duality’ prevented the community from reaching consensus on accountability. See Paula Ungureanu and others, ‘Dealing with Blame in Digital Ecosystems: The DAO Failure in the Ethereum Blockchain’ (June 2025) 215 Technological Forecasting and Social Change para 4.2.1, <<https://doi.org/10.1016/j.techfore.2025.124096>>.

¹² Mireille Hildebrandt, ‘Algorithmic Regulation and the Rule of Law’ (2018) 376, 2128 Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences 2, <<https://doi.org/10.1098/rsta.2017.0355>>. Hildebrandt argues that text-driven law maintains a crucial distinction between legal norms and their enforcement through its performative nature, which ‘does what it says, by attributing legal effect when certain legal conditions are met’ while simultaneously ‘requiring that government agencies provide reasons based on the applicable legal norms, thus making government actions and decisions explainable and contestable’ (6). This creates what Dworkin called ‘the space between’ rules (5), where discretion permits interpretation and contestation. Code-driven and self-executing algorithmic regulation threatens to collapse this space by integrating ‘standard-setting with behaviour modification’ (2), thereby eliminating the interpretive gap that allows for contextual judgment and equitable adjustment. Legal norms expressed in ‘notably ambiguous’ human language are ‘not merely cumbersome compared to code-driven regulation, but – on the contrary – also protect [...] us from over-inclusive as well as under-inclusive legal norms’ (3).

present this as establishing a more precise and predictable legal environment, critics contend that it risks sacrificing essential legal values: the capacity for contextual judgment, the protection of vulnerable parties, and the democratic contestability of legal outcomes.¹³

The normative implications of this shift remain contested. Does the elimination of interpretive space represent progress toward efficiency and certainty, or does it constitute a dangerous impoverishment of law's capacity to serve justice and adapt to human complexity?

2.2. *Deterritorialization and the Question of Sovereign Authority*

Decentralized blockchain (discussed below) structures also challenge traditional legal systems by aspiring to sever the intrinsic connections between law, political sovereignty, and territorial boundaries that have defined the Westphalian order since the seventeenth century.¹⁴ These systems seek to establish legal frameworks that operate independently of the State's symbolic authority, effectively detaching legal validity from territorial jurisdiction.

In this evolving landscape, we observe the emergence of transnational, acephalous systems wherein *lex cryptographia* purports to operate autonomously across borders,

¹³ Claims that decentralization renders blockchain 'alegal' or beyond legal boundaries are overstated. De Filippi, Mannan, and Reijers advance this thesis based on blockchain's decentralization and related features, yet their own case study of The DAO hack demonstrates that even highly decentralized systems remain subject to governance intervention acknowledging 'collective community intervention ultimately succeeded' despite alleged alegality, Primavera De Filippi and others, 'The Alegality of Blockchain Technology' (2022) 41(3) Policy and Society 358, 365, <<https://doi.org/10.1093/polsoc/puac006>>. The concept itself originates from Ethereum co-founder Gavin Wood's libertarian ideology rather than neutral analysis. As Verstraete argues, blockchain advocates 'fundamentally underestimate the role of the state in maintaining a functioning private law regime' and perpetuate 'deeply contested assumptions from Lochner-era legal thought.' Mark Verstraete, 'The Stakes of Smart Contracts' (2019) 50, 3 Loyola University Chicago Law Journal 766. Decentralization creates enforcement challenges, not legal immunity – a distinction law has managed with other transnational technologies from offshore banking to peer-to-peer networks. See also Michèle Finck, 'Smart Contracts as a Form of Solely Automated Processing Under the GDPR' (2019) SSRN Electronic Journal, <<https://doi.org/10.2139/ssrn.3311370>> assuming GDPR framework adequately captures smart contract regulation without questioning its conceptual fit.

¹⁴ David R. Johnson and David G Post, 'Law and Borders - The Rise of Law in Cyberspace' (1997) SSRN Electronic Journal 1370, 1387, <<https://doi.org/10.2139/ssrn.535>> arguing that cyberspace's independence from physical location fundamentally undermines territorial sovereignty and necessitates distinct self-regulatory legal regimes. Johnson and Post's framework presciently anticipated how decentralized technologies would challenge the Westphalian system, which since 1648 has anchored legal authority in territorially bounded state sovereignty. Their analysis suggests that blockchain structures would create autonomous governance systems functioning through cryptographic consensus mechanisms rather than state-backed enforcement – a development that fundamentally questions what Saskia Sassen describes as 'the effectiveness of current framings for state authority' and signals 'new types of imbrications between authority and territory, and more specifically, place.' Saskia Sassen, *Territory, Authority, Rights: From Medieval to Global Assemblages* (Princeton University Press 2006) 329.

emancipated from the cultural and national foundations that have traditionally conferred legal legitimacy.¹⁵ Within these decentralized communities, legal authority remains both formally headless and spatially virtual, complicating conventional understandings of sovereignty, jurisdiction, and the enforcement of judgments.

Additionally, decentralization enables the development of what some theorists term ‘cloud communities’¹⁶ or State-like non-territorial polities that employ opt-in legal systems.¹⁷ This model ostensibly removes the need for compromise and deliberation on shared values – processes that have historically been regarded as essential to the democratic legitimacy of law.¹⁸ Instead, legal authority would derive from voluntary participation and cryptographic verification rather than democratic authorisation.

However, the deterritorialized aspirations of blockchain systems encounter persistent constraints. Territorial States continue to assert jurisdictional authority over blockchain activities that produce effects within their borders.¹⁹ Regulatory interventions – ranging from China’s ban on cryptocurrency exchanges to the European Union’s Markets in Crypto-Assets Regulation (MiCAR) and the US Genius Act – demonstrate that territorial sovereignty remains a formidable force shaping blockchain’s actual operation, regardless of its ideological commitments.²⁰ The question

¹⁵ See Kevin Werbach, *The Blockchain and the New Architecture of Trust* (Information Policy Series, The MIT Press 2018) discussing how blockchain systems create ‘distributed, algorithmic trust structures’ that operate independently of ‘human-interpreted, state-backed institutions of law’; see also discussion at pages 203 examining tensions between cryptographic governance mechanisms and traditional legal frameworks, noting that on public blockchain networks ‘participants have less leverage’ than in conventional contractual relationships, and observing that while ‘blockchain technology addresses a particular governance challenge – consensus about the status of the ledger – in a new way (...) that does not by itself resolve the higher-level coordination challenges that blockchain networks face’.

¹⁶ Liav Orgad, ‘Cloud Communities: The Dawn of Global Citizenship?’ (29 April 2018) Globalcit, <<https://globalcit.eu/cloud-communities-the-dawn-of-global-citizenship/>> accessed 8 February 2026.

¹⁷ See Werbach (n 15) 100, observing that in blockchain systems, ‘those who do not trust the law can more easily relocate to a more favorable jurisdiction (...) or they can use cryptography to hide from it’, effectively creating transnational communities based on cryptographic governance and opt-in mechanisms.

¹⁸ The democratic legitimacy of law depends on deliberative processes through which citizens, through public debate and compromise, develop a shared understanding of the values and norms that govern them; procedural legitimacy requires that ‘the addressees of law are also able to understand themselves as its authors’, Jürgen Habermas, *Between Facts and Norms: Contributions to a Discourse Theory of Law and Democracy* (Studies in Contemporary German Social Thought, MIT Press 1999) 104.

¹⁹ ‘Many issuers of ICOs seem to believe that these instruments exist beyond the jurisdiction of national laws and courts. We do not accept this belief – courts are loath to cede jurisdiction’. As noted in Dirk A Zetzsche and others, ‘The ICO Gold Rush: It’s a Scam, It’s a Bubble, It’s a Super Challenge for Regulators’ (2018) CGN: Investment in R&D & Innovation (Topic) 282, <<https://api.semanticscholar.org/CorpusID:158097322>> accessed 8 February 2026.

²⁰ Robby Houben and Alexander Snyers, *Crypto-Assets – Key Developments, Regulatory Concerns and Responses*, (Policy Department for Economic, Scientific and Quality of Life Policies, European Parliament, PE 648.779, April 2020) <<https://www.europarl.europa.eu/RegData/etudes/STUD/20>

thus becomes not whether blockchain has escaped territorial law, but rather how these competing claims to legal authority interact and which will prove dominant in specific contexts.

Consequently, while code emerges as a novel symbolic referent in this legal framework – one that seeks to displace the trust traditionally invested in State institutions – this displacement remains incomplete and contested. The tension between blockchain's deterritorialized aspirations and the persistent relevance of territorial jurisdiction constitutes a central problematic requiring ongoing empirical and theoretical investigation.

2.3. *The Elusiveness of Jurisdiction and the Limits of Enforcement*

The core difficulty stems from the belief that blockchain technology can 'fracture economic and social processes' and operate autonomously, 'independently of any government or other centralized authority.'²¹

The decentralized and transnational nature of Blockchain systems poses profound challenges to traditional concepts of jurisdiction and enforcement. These challenges operate at multiple levels: determining applicable law, establishing jurisdictional authority, and implementing effective enforcement mechanisms.

Traditionally, jurisdiction is defined either by the authority of a court to adjudicate cases or by the territory within which a court or government agency may exercise its power.²² Decentralized systems deliberately challenge this geographical anchoring, leading to profound conflicts regarding applicable law and judicial authority. The decentralized blockchain structure is said to sever all legal ties to any specific territory.²³

This *a-territorial* and *a-spatial* dimension of the digital space means that decentralized networks operate across national borders, tending to remain scarcely regulated under domestic and supranational laws.²⁴ The *a-territorial* character of blockchain networks fundamentally disrupts the geographic foundations upon which jurisdictional rules have historically been constructed.

20/648779/IPOL_STU(2020)648779_EN.pdf> accessed 8 February 2026, noting that despite crypto-assets' cross-border nature, effective regulation requires coordinated national and supranational intervention to address money laundering, financial stability, and investor protection concerns.

²¹ Konrad Hummler, 'Blockchain – der nächste Wohlstandsschock | NZZ' (3 May 2016) *Neue Zürcher Zeitung*, <<https://www.nzz.ch/finanzen/private-finanzen/herausforderung-fuer-banken-und-den-staat-blockchain-der-naechste-wohlstandsschock-ld.17609>> accessed 8 February 2026.

²² Wesley Thyse, *Decentralized Law: The Power of Blockchain to Transform the Broken Legal System* (Thyse Publishing 2025) 215, <<http://archive.org/details/decentralized-law>> accessed 8 February 2026.

²³ Becker, 'Blockchain Matters – Lex Cryptographia and the Displacement of Legal Symbolics and Imaginaries', 119ff.

²⁴ Cristina Poncibò, 'Blockchain and Comparative Law', in Benedetta Cappiello and Gherardo Carullo (eds), *Blockchain, Law and Governance* (Springer International Publishing 2021) 153, <https://doi.org/10.1007/978-3-030-52722-8_10>.

2.3.1. *Jurisdictional Ambiguity and Choice of Law*

Traditional private international law relies on connecting factors that link legal relationships to specific territories. The Rome I Regulation (EC 593/2008), which governs choice of law for contractual obligations within the European Union, exemplifies this approach. Article 4 establishes a hierarchy of connecting factors, with particular emphasis on the ‘habitual residence’ of the service provider or, in the absence of such identification, the place where the central administration is located.

However, these connecting factors become problematic – indeed, potentially meaningless – when applied to DAO or blockchain-based contractual arrangements. A DAO exists simultaneously everywhere and nowhere: its smart contracts execute on distributed nodes across multiple jurisdictions, its governance tokens may be held by pseudonymous participants globally dispersed, and its treasury may consist of crypto-assets with no physical location. Where is the ‘habitual residence’ of such an entity? Where is its ‘central administration’ when decision-making occurs through on-chain voting mechanisms without any physical headquarters?

The escape clause in Rome I (Article 4(3)) allows courts to apply the law of a country with which the contract is ‘manifestly more closely connected.’ However, this provision presupposes the existence of such a country – an assumption that decentralized systems deliberately challenge. The result is jurisdictional ambiguity that creates opportunities for regulatory arbitrage and forum shopping. Projects may structure their token distributions, governance mechanisms, and operational parameters specifically to avoid or minimise connections to jurisdictions with stringent regulatory requirements.²⁵ This is achieved partly through jurisdictional ambiguity: DAOs are often designed without an official domicile, which complicates the application of corporate, tax, and capital market laws.²⁶ Furthermore, the complexity of identifying parties in a distributed system makes it ‘almost impossible’ to determine competent jurisdiction in a predetermined manner.²⁷

Moreover, DAOs present classification challenges that precede choice-of-law analysis. Are they partnerships? Unincorporated associations? Sui generis entities? The answer to this preliminary question determines which choice-of-law rules apply, yet the answer remains contested. This creates what might be termed ‘double indeterminacy’: uncertainty about both the applicable classification framework and the applicable substantive law.

2.3.2. *Enforcement Challenges in Decentralized Systems*

Even when applicable law can be determined and jurisdiction established,

²⁵ Muhammad Anus and Allauddin Allauddin, ‘The Legal Fiction of “Decentralization”: How DAOs Are Accidentally Creating Unregulated Financial Entities’ (2025) SSRN 7, <<https://doi.org/10.2139/ssrn.5396997>>.

²⁶ *ibid* 16.

²⁷ Francisco Pereira Coutinho and others (eds), *Blockchain and the Law: Dogmatics and Dynamics* (Information Technology and Law Series, vol. 37, T.M.C. Asser Press 2024) 24.

enforcement presents formidable obstacles. Traditional legal enforcement presupposes the existence of identifiable defendants who can be served with process, whose assets can be located and seized, and who can ultimately be compelled to comply with judicial orders. Decentralized systems resist these assumptions at every step.

The concept of the ‘veil of decentralization’ captures this dynamic: just as the corporate veil shields individual shareholders from liability, the architecture of decentralization creates a liability shield – but one without an identifiable entity behind it. There is no ‘DAO Inc.’ to sue, no board of directors to hold accountable, no CEO to compel to testify. Legal process confronts a distributed network of pseudonymous participants, none of whom may individually possess the authority or capacity to provide the relief sought.

Smart contract immutability compounds enforcement difficulties. Once deployed to the blockchain, code executes autonomously according to its programmed logic. A court order demanding that a smart contract cease operation, modify its behaviour, or reverse a transaction encounters a fundamental problem. There may be no party capable of implementing such an order. The code operates permissionlessly, continuing to execute regardless of legal judgments. While validators could theoretically coordinate to fork the blockchain and reverse transactions, such interventions contradict the ideology of immutability and face collective action problems.

Asset seizure – a traditional mechanism for satisfying judgments – becomes equally problematic. When smart contracts manage a DAO’s treasury, private keys may be distributed via multi-signature arrangements or threshold cryptography. No single party may possess the unilateral capacity to transfer assets in compliance with a court order. Even if enforcement authorities could identify and compel cooperation from key-holders, cryptocurrency’s censorship-resistant properties and the potential for assets to be transferred across chains create additional obstacles.

Cross-border coordination difficulties further undermine the effectiveness of enforcement. Blockchain networks operate globally, yet legal enforcement mechanisms remain primarily national. A judgment issued by a court in one jurisdiction may prove difficult or impossible to enforce in others, particularly when relevant parties or assets reside in jurisdictions with weak international cooperation frameworks or hostile attitudes toward such enforcement actions.

2.4. Disembodiment and the Paradox of Legal Subjectivity

Decentralization significantly challenges traditional conceptions of legal subjectivity, which have historically been constructed around the juridical concept of legal personality. This concept abstracts the legal person from biological particularity while simultaneously depending upon embodied human agency.²⁸ Within the

²⁸ Ngairé Naffine, *Law’s Meaning of Life: Philosophy, Religion, Darwin and the Legal Person* (Bloomsbury Academic 2009) 33, 34. As Naffine explains, drawing on Kelsen, legal persons are ‘purely legal abstractions’ constituting ‘a technical personification of a complex of norms, a focal point

aspirational framework of *lex cryptographia*, the physical body is conceptually rendered as a non-programmable entity, ostensibly excluded from direct representation in blockchain legal systems, even as these systems continue to produce effects on embodied subjects.

This creates what might be understood as a dual movement: the body loses its authoritative position as the presumptive locus of legal agency while simultaneously being relegated to the status of a mere biological object external to the system's primary operations.²⁹ Legal personality becomes increasingly detached from human embodiment, potentially migrating instead to algorithmic agents (such as agentic AI), smart contracts, or DAOs that operate according to programmatic logic rather than human will.³⁰

However, this disembodiment proves paradoxical and incomplete in practice. Bodies remain stubbornly relevant to blockchain systems in multiple ways: through biometric identity verification systems that increasingly govern access; through the embodied labor of developers, miners, and users whose physical actions sustain the infrastructure; through the material consequences of algorithmic decisions that affect nutrition, healthcare, housing, and physical security; and through the legal recourse available when code produces harmful outcomes that territorial legal systems may still remedy.³¹

Furthermore, the fantasy of disembodied legal agency obscures important questions about power, inequality, and access. Who possesses the technical

of imputation which gives unity to certain complexes of rights and duties'. As she notes, 'there is nothing in the notion of the subject of rights which in itself would, necessarily, connect it with human personality, or even with anything experimentally existing' (citing Alexander Nekam, *The Personality Conception of the Legal Entity* (Harvard University Press 1938) 26). This juridical separation of legal personality from biological humanity traces back to Roman law's foundational principle that *homo vocabulum est naturae; persona juris civilis* [Man is a term of nature; person, of civil law], demonstrating how 'the definitive separation of person from human being that occurs in the modern period' maintains 'points of contact with the Roman category'. Roberto Esposito, 'The Dispositif of the Person' (2012) 8 Law, Culture and the Humanities 25, <<https://doi.org/10.1177/1743872111403104>>.

²⁹ See Antoinette Rouvroy and Thomas Berns, 'Gouvernementalité Algorithmique et Perspectives d'émancipation: Le Disparatisme Comme Condition d'individuation Par La Relation?' (2013) 177 (1) Réseaux 163 <<https://doi.org/10.3917/res.177.0163>>.

³⁰ On the challenges posed by algorithmic agents and smart contracts to traditional legal frameworks of attribution and legal personality, see Scholz (n 10); Philipp Hacker, 'Proposal for a Directive on Adapting Non-Contractual Civil Liability Rules to Artificial Intelligence: Complementary Impact Assessment' (September 2024) European Parliamentary Research Service Study PE 762.861.

³¹ On the tension between blockchain's aspirational decentralization and the stubborn persistence of physical reality – including the role of bodies, infrastructure, and territorial legal authority – see Firat Cengiz, 'Blockchain Governance and Governance via Blockchain: Decentralized Utopia or Centralized Dystopia?' (2023) 6(4) Policy Design and Practice; Casey Watters, 'When Criminals Abuse the Blockchain: Establishing Personal Jurisdiction in a Decentralised Environment' (2023) 33 Laws 12, <<https://doi.org/10.3390/laws12020033>>. Cengiz observes that blockchain governance must contend with the materiality of infrastructure and the reassertion of state power through surveillance mechanisms, while Watters examines how territorial jurisdiction reasserts itself in prosecuting blockchain-related crimes precisely because physical location ultimately determines legal authority despite the technology's borderless aspirations.

literacy, economic resources, and social capital to participate meaningfully in supposedly neutral blockchain systems? Whose bodies are rendered more vulnerable by the withdrawal of interpretive flexibility and institutional oversight?³² The unrepresented but consequential presence of the human body thus creates a constitutive tension within blockchain legal systems – a tension between the ideology of algorithmic autonomy and the persistent materiality of embodied human existence.

This transformation does not simply replace one form of legal subjectivity with another. Instead, it generates a complex field of competing modes of agency: the robotised presence of smart objects seamlessly integrated into algorithmic frameworks coexists uneasily with the excluded-yet-affected presence of biological bodies.³³ Understanding this paradox requires moving beyond technological determinism to examine how different actors negotiate, resist, or are subjected to these new configurations of legal power.

2.5. *Regulatory Responses*

Regulators and courts have begun developing strategies to address these challenges, though the approaches remain experimental and their efficacy is uncertain. Two developments merit particular attention so far: the Ooki DAO enforcement action and the European Union's Markets in Crypto-Assets Regulation.

2.5.1. *The Ooki DAO Case*

In September 2022, the US CFTC filed an enforcement action against *Ooki DAO*, marking a significant regulatory development.³⁴ The CFTC alleged that

³² On the tensions between blockchain's decentralized architecture and persistent power concentrations, see Marcella Atzori, 'Blockchain Technology and Decentralized Governance: Is the State Still Necessary?' (2017) 6(1) *Journal of Governance and Regulation* 45, particularly her discussion of 'risks related to a dominant position of private powers in distributed ecosystems'.

³³ The concept of competing modes of agency draws on scholarship examining how algorithmic systems create new forms of legal and economic agency. Lauren Henry Scholz describes how algorithms function as 'constructive agents' in contract formation, with 'black box' algorithmic agents producing emergent results that their creators cannot foresee or control; see Scholz (n 10). On how human-machine agency interactions resist binary categorisation (humans-in-the-loop vs. humans-out-of-the-loop), see Christian Katzenbach and Lena Ulbricht, 'Algorithmic Governance' (2019) 8(4) *Internet Policy Review* <<https://doi.org/10.14763/2019.4.1424>>. For the theoretical framework on disembodiment and posthuman subjectivity, see N Katherine Hayles, *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics* (University of Chicago Press 1999), particularly her critique of how 'information lost its body' in cybernetic discourse. The paradox of exclusion-yet-affectedness is documented empirically in Virginia Eubanks, *Automating Inequality: How High-Tech Tools Profile, Police, and Punish the Poor* (St. Martin's Press 2018), which demonstrates how vulnerable populations 'experience technology as a harmful extension of disciplinary systems' while being denied meaningful participation in algorithmic governance.

³⁴ 'Statement of CFTC Division of Enforcement Director Ian McGinley on the Ooki DAO Litigation Victory', <<https://www.cftc.gov/PressRoom/PressReleases/8715-23>> accessed 25 November 2025.

Ooki DAO offered illegal leveraged trading of digital assets and failed to implement proper KYC and AML procedures. Rather than identifying individual defendants, the CFTC named the DAO itself and, critically, served the DAO's token holders collectively through governance forums and online platforms. The CFTC's theory rested on functional control: token holders who participate in governance effectively control the DAO and therefore bear responsibility for its legal compliance. This approach treats governance participation as evidence of an agency or partnership relationship, potentially exposing token holders to liability for the DAO's violations. The case raises profound questions about the extent to which passive token holders or small-scale governance participants can be held liable for organisational misconduct they may have been unable to prevent.

2.5.2. EU MiCAR Framework

Rather than focusing exclusively on the novel characteristics of decentralized systems, MiCA seeks to identify functional equivalents to traditional financial actors and impose corresponding obligations on them. Other than establishing a typology of crypto-assets (e-money tokens, asset-referenced tokens, and other crypto-assets) with tailored requirements for each category; creating an authorization regime for crypto-asset service providers, capturing activities such as exchange services, custody, portfolio management, and investment advice; most relevant to enforcement challenges, MiCAR requires the identification of responsible 'issuers' and 'offerors' who bear legal obligations regarding disclosure, governance, and operational standards. For ostensibly decentralized projects, MiCA's approach involves piercing through the rhetoric of decentralization to identify *de facto* controllers. Projects claiming to lack any responsible party will find such claims receive limited credence. Regulators may identify core developers, foundation entities, large token holders, or others exercising meaningful influence as responsible parties for regulatory compliance purposes.

2.5.3. Emerging Strategies

These regulatory responses reflect broader strategies to address decentralization's enforcement challenges. First, functional analysis: looking beyond formal structures to identify who controls systems and allocating responsibility accordingly. Second, participant liability: extending liability to ecosystem participants – validators, liquidity providers, governance participants – based on their roles and degree of involvement. Third, service provider regulation: focusing enforcement on centralized points of contact with the traditional financial system, such as exchanges and custodians, even when the underlying protocols remain decentralized. Fourth, technical mandates: requiring that smart contracts and protocols incorporate compliance functionality, such as transaction monitoring or the ability to respond to legal orders, as a condition of regulatory approval.

These strategies represent adaptations of traditional legal tools to novel technological circumstances. Their long-term efficacy remains uncertain, dependent on international coordination, technical feasibility, and the willingness of courts to accept novel theories of responsibility and control.

3. *Law as a System Founded on 'Centres of Attribution'*

The inevitable question is that the traditional legal paradigm operates fundamentally as a system founded upon and necessitating identifiable 'centres of attribution,' a structure essential for realising the primary function of law as the main tool for social order. This system of centralized law is typically characterised by being imposed from above by an authoritative institution whose power to rule is both genuine and legitimate, deriving from political action and the will of the rulers. This political authority grants the State, or its designated agencies, the requisite monopoly of coercive power for the ultimate enforcement and application of legal sanctions. This structured exercise of force, balanced against individual rights, constitutes the core mechanism of the rule of law.

The efficacy and certainty indispensable to this traditional legal system rely on defining and fixing these centres across several critical domains. Organisational law provides the necessary 'impermeable barriers' and frameworks for groups of people, allowing the system to structure accountability and risk. This institutional anchoring of accountability is non-negotiable within the current paradigm.

Furthermore, this reliance on fixed centres allows the legal system to act as a crucial 'supplier of fictional certainty' where technology or reality itself cannot provide absolute deterministic outcomes. This 'institutional backstop' is critical, particularly in complex commercial spheres. For instance, concepts fundamental to modern finance, such as achieving absolute 'operational finality' in transactions, are acknowledged as nearly impossible;³⁵ therefore, the law intervenes to impose 'legal finality' through presumptions and rules, providing the certainty required to mitigate systemic risks, particularly those arising in insolvency or bankruptcy proceedings. The coherence of the rule of law is thus preserved by defining these explicit points of connection and control, enabling reliable adjudication and the protection of established rights.³⁶ The core challenge posed by technology-based decentralization, and the concept of *lex cryptographia*, lies in their foundational ethos, which seeks radical emancipation from the constitutive legal dimensions: territory, language, and the physical body. The challenge, therefore, is not simply one of regulatory adaptation but of confronting whether law as we have understood it – as a system of centred attribution – can meaningfully operate in a genuinely acephalous, distributed environment, or whether the persistence of legal order necessarily requires the (re)imposition of identifiable centres, even within ostensibly decentralized structures.

³⁵ See Rosa Giovanna Barresi, 'The Evolution of the Finality of Payment or How RTGSs, Instant Payment Systems, and DLT Platforms Change the Concept of Money', in Filippo Zatti and Rosa Giovanna Barresi (eds), *Digital Assets and the Law* (1st edn Routledge 2023), <<https://doi.org/10.4324/9781003258261-19>>.

³⁶ Edoardo D Martino and W Georg Ringe, 'The Social Cost of Blockchain: Externalities, Allocation of Property Rights, and the Role of the Law' (2024) 80 Institute of Law and Economics Working Paper 5, 17 (emphasising law's essential role in providing clear property rights allocation and legal finality for blockchain transactions).

To address this need for research, it is necessary to verify that decentralization does not hinder but rather facilitates the achievement of the constitutional objectives of centralized legal systems. In addition, it is key to ensure that this technological decentralization does not erode the fundamental principles and values upon which Constitutions are founded. In a technologically decentralized context, power is not merely granted but rather intercepted through solutions that begin with fragmentation and ultimately converge towards unity. This approach stands in contrast to the more conventional top-down approach, where power is assumed and then organised to serve the community.

3.1. *The Theoretical Facilitation of Constitutional Ideals*

Having examined the fundamental challenges that decentralization poses to traditional legal paradigms – the displacement of foundational symbolics, the deterritorialization of authority, the elusiveness of jurisdiction, the paradoxes of legal subjectivity, and the resistance to centres of attribution – we must now consider the normative claims made on behalf of blockchain technology. Proponents argue that decentralized systems may facilitate certain constitutional ideals even as they challenge traditional legal structures. This subsection examines these claims while maintaining critical awareness of tensions with the preceding critique.

Decentralization, in its ideal form, embodies features that resonate strongly with modern constitutional and democratic ideals, particularly concerning transparency, efficiency, and participation.

One primary objective of any modern legal system is to ensure predictable, fair, and accountable governance. Decentralization proponents argue that the technology achieves this through algorithmic transparency and the elimination of traditional ‘Single Points of Failure’ associated with human-centric centralized institutions. According to this perspective, the use of open-source code and on-chain records in decentralized systems ensures data is publicly verifiable and difficult to manipulate. This enhances accountability by allowing real-time monitoring of decisions and financial flows, an objective that many State-based systems struggle to meet, especially in complex bureaucratic or financial operations.³⁷ Decentralization would aim to disperse power away from a central entity that might otherwise be susceptible to regulatory capture, corruption, or misuse of power. This would align with the constitutional goal of preventing authoritarian drift and ensuring that the government is subject to the rule of law.³⁸

³⁷ See Primavera De Filippi and Aaron Wright, *Blockchain and the Law: The Rule of Code* (Harvard University Press 2018); Werbach (n 15) 95ff, on how distributed consensus mechanisms and open-source protocols enable algorithmic transparency while eliminating centralized points of failure; and Kelsie Nabben, ‘Blockchain Governance: Accountability in Decentralised Technology Communities’ (11 May 2023) Substack newsletter, Kelsie – on the Cataclysmia of Digital Infrastructure, <<https://kelsienabben.substack.com/p/blockchain-governance-accountability>> accessed 8 February 2026, on how on-chain transparency enhances real-time accountability compared to traditional bureaucratic systems.

³⁸ On decentralization dispersing power away from entities susceptible to regulatory capture and

Moreover, decentralized applications (dApps) and DAOs, which promote models of direct and collaborative decision-making, would offer new ways to realise the constitutional ideals of political participation and effective justice. DAOs and platforms like *Kleros* and *Jur* would enable liquid democracy and collective dispute resolution, leveraging consensus mechanisms to govern resource allocation and resolve conflicts. This can be interpreted as facilitating participatory governance, enhancing citizen involvement beyond traditional representative structures. Decentralized dispute resolution systems specifically target low-value, high-volume transactions, providing affordable mechanisms to solve ‘micro-claims’ that often lack affordable recourse in traditional, expensive court systems. This expands access to justice, a core constitutional objective.

3.2. *The Fundamental Conflict with Constitutional Prerequisites*

Despite these potential benefits, the core claim of technological decentralization fundamentally clashes with essential constitutional objectives, particularly those concerning sovereignty, legal certainty, and accountability.

Constitutional systems presuppose the existence of ultimate authority – a sovereign capable of making binding collective decisions and resolving conflicts authoritatively. Decentralized systems resist this requirement. By design, they lack ultimate authority: no entity can unilaterally modify protocols, reverse transactions, or resolve disputes authoritatively. This refusal of sovereignty is presented as a virtue – liberation from hierarchical power. Nevertheless, it creates fundamental problems for constitutional governance. How are constitutional amendments adopted? How are irreconcilable conflicts resolved? How is the boundary between permissible and impermissible conduct authoritatively determined?

Constitutional authority traditionally operates through territorial jurisdiction: the State exercises sovereign power within defined borders. As seen, Blockchain aspires to transcend such territorial limitations, creating legal orders without geographic anchoring. However, this deterritorialization should eliminate one of constitutionalism’s foundational mechanisms: the definition of a political community bound together by shared subjection to common authority.

Moreover, governance rights derive from token ownership, which reflects economic power rather than equal citizenship. The initial distribution of tokens typically occurs through sales or airdrops that favour early participants, insiders, or those

corruption, see Atzori (n 32); Primavera De Filippi and Benjamin Loveluck, ‘The Invisible Politics of Bitcoin’ (2016 5(3) Internet Policy Review. For the alignment with constitutional goals of preventing authoritarian drift through power dispersal, see Lewis Mumford, ‘Authoritarian and Democratic Technics’ (1964) 5(1) Technology and Culture 1; and Morshed Mannan, Primavera De Filippi and Wessel Reijers, ‘The Emergence of Blockchain Constitutionalism’ in Giovanni De Gregorio, Oreste Pollicino and Peggy Valcke (eds), *The Oxford Handbook of Digital Constitutionalism* (1st edn, Oxford University Press 2024) <<https://academic.oup.com/edited-volume/58210/chapter/488309540>> accessed 5 February 2026, examining blockchain’s relationship to constitutional principles including separation of powers and rule of law.

with capital to invest – not through any process claiming democratic legitimacy. Subsequent distributions through the market further concentrate tokens in the hands of those with greater resources. ‘Governance by numbers’³⁹ replaces deliberative democracy with algorithmic aggregation of preferences but eliminates the deliberative process through which preferences are formed, refined, and synthesised into collective judgments. Cloud communities and opt-in systems allow fragmentation: those who disagree can exit rather than compromise. While this may satisfy individuals’ preferences, it abandons the constitutional project of constructing shared frameworks for collective life despite disagreement.

Empirically, ostensibly decentralized systems often exhibit significant power concentration. Core developers exercise disproportionate influence over protocol evolution: while anyone can formally propose changes, practical authority resides with those possessing technical expertise and credibility within developer communities. Their decisions about which improvements to implement, which bugs to prioritise, and how to respond to crises shape system evolution more profoundly than token holder votes. Token distribution patterns reveal similar concentration. ‘Whales’ – holders of prominent token positions – dominate governance outcomes when they choose to participate. Analysis of DAO voting patterns consistently shows highly unequal participation and influence.⁴⁰

These distributional inequities may give rise to oligarchic governance structures beneath decentralization’s egalitarian rhetoric.⁴¹ The plutocratic character of token voting means that those who already possess wealth can entrench their advantages by controlling protocol governance, putting them in a position to evade accountability. By disclaiming the existence of any controlling party, they deny that anyone owes fiduciary duties. Token holders disclaim responsibility despite exercising governance rights. Developers claim merely to propose code changes

³⁹ Rouvroy and Berns (n 29).

⁴⁰ On how DAOs theoretically enable participatory governance through token-based voting and liquid democracy mechanisms, see Robin Fritsch and others, ‘Analyzing Voting Power in Decentralized Governance: Who Controls DAOs?’ (2024) 28(3) IEEE Internet Computing 124; and Kelsie Nabben, ‘Blockchain Governance: Accountability in Decentralised Technology Communities’ (11 May 2023) Substack newsletter. However, for critical analysis of how these mechanisms often fail to achieve genuine participation in practice, see below.

⁴¹ Building on the voting power concentration documented above, recent empirical studies provide even more striking evidence of inequality. Johnnatan Messias and Ayae Ide, ‘Fairness in Token Delegation: Mitigating Voting Power Concentration in DAOs’ (2025) version 1, preprint, arXiv, <<https://doi.org/10.48550/ARXIV.2510.05830>>, demonstrated Gini coefficients ranging from 0.97 to 0.99 across 10 major DAOs – significantly exceeding even the most unequal nation-states (South Africa: 0.63 in 2024). Johnnatan Messias and others, ‘Understanding Blockchain Governance: Analyzing Decentralized Voting to Amend DeFi Smart Contracts’ (2023) version 4, arXiv, <<https://doi.org/10.48550/ARXIV.2305.17655>>, also found that in Compound, only 3 voters could achieve 50% of votes on proposals. For systematic evidence that delegation mechanisms ‘exacerbate centralization, particularly when whales or influential networks are disproportionate,’ see Lukas Weidener and others, ‘Delegated Voting in Decentralized Autonomous Organizations: A Scoping Review’ (June 2025) 8 *Frontiers in Blockchain* 1598283, <<https://doi.org/10.3389/fbloc.2025.1598283>>.

that others are free to reject. Platform operators assert they simply facilitate access to decentralized protocols. Everyone disclaims control, yet collectively the system operates and produces consequences for participants. This structure creates a moral hazard: those who exercise effective control over systems escape the legal obligations traditionally accompanying such power. They enjoy the benefits of governance participation – the ability to shape protocols in ways that advantage their interests – without bearing corresponding responsibilities to those affected by their decisions.

The enforcement blind spots discussed in section 2 compound these accountability deficits. Even when legal duties theoretically attach, enforcement proves difficult or impossible when responsible parties cannot be identified or when their pseudonymity and distributed coordination frustrate the legal process.

4. *The Necessity of Hybridisation and Legal Anchoring*

This analysis reveals that pure decentralization risks eroding constitutional accountability mechanisms. Pragmatic approaches, therefore, favour hybrid arrangements that harness blockchain's technical advantages while maintaining essential legal safeguards.

DLTs require institutional and legal anchors to function responsibly within the broader economy. As a result, the approach so far has primarily been for law to engage actively with these new organisational solutions, as the Ricardian contract approach confirms, enabling smart contracts to function seamlessly within established legal frameworks. Another adaptation is to evolve regulatory frameworks to ensure that technological innovations can coexist with traditional legal functions. Jurisdictions are tasked with defining rules that establish the functional equivalence of these technologies, all while safeguarding fundamental rights. An exemplary initiative highlighting this need is the EU's DLT Pilot Regime, which mandates the presence of an identifiable and liable operator for DLT market infrastructures.⁴²

⁴² Regulation (EU) 2022/858 of the European Parliament and of the Council of 30 May 2022 on a Pilot Regime for Market Infrastructures Based on Distributed Ledger Technology, OJ L 151/1 (2 June 2022). Article 4(1) mandates that DLT market infrastructures must have identifiable operators with clearly defined chains of liability. Recital 12 explicitly states: 'DLT market infrastructures and their operators should have in place adequate safeguards related to the use of distributed ledger technology to ensure the effective protection of investors, including clearly defined chains of liability to clients for any losses due to operational failures.' Article 6(11) further specifies that competent authorities may require additional prudential safeguards 'in order to ensure investor protection.' This requirement demonstrates a fundamental point: even experimental regulatory frameworks designed specifically to accommodate blockchain innovation ultimately require identifiable centers of attribution. As detailed in Giovanni Zaccaroni, 'Decentralized Finance and EU Law: The Regulation on a Pilot Regime for Market Infrastructures Based on Distributed Ledger Technology' (September 2022) 7 *European Papers – A Journal on Law and Integration* 601, <<https://doi.org/10.15166/2499-8249/581>>, operators can free themselves from responsibility only by proving losses resulted from external events beyond reasonable control, thereby establishing a presumption of liability. The DLT Pilot

This requirement underscores the importance of having a centralized, accountable entity that can interface with the legal system, even within decentralized contexts. Another solution to gain traction is to address governance through a polycentric lens.⁴³ This means recognising that multiple governing bodies – spanning local, national, international, and private decentralized networks – must interact and coordinate effectively. Establishing clear rules for how on-chain regulations align with off-chain national or international laws becomes crucial in this framework.

However, this attempt to harness the benefits of decentralization without reverting to a pre-political State dominated by unaccountable private interests must find a conscious and constructive way to cooperate with existing legal structures. This cooperation should emphasise regulations that mandate governance transparency, enforce accountability, and protect fundamental rights. Ultimately, a way to embrace decentralization should be regarded as an organisational theory that enhances the legal order's effectiveness rather than a standalone political theory capable of replacing it.⁴⁴ The solution is not singular but inevitably resides in a multi-layered approach that necessitates both adapting existing legal frameworks and strategically introducing new, technology-aware legal and institutional mechanisms. This aims to find an equilibrium between the code-based *lex cryptographia* and the State-based *rule of law*.

Regime thus proves that legal integration necessarily requires re-centering: the price of regulatory approval is the abandonment of pure decentralization.

⁴³ The concept of polycentricity, originating with Vincent and Elinor Ostrom, describes governance systems with multiple autonomous decision-making centers that coordinate through overlapping jurisdictions and shared rules. Elinor Ostrom, 'Beyond Markets and States: Polycentric Governance of Complex Economic Systems' (2010) 100(3) *American Economic Review* 641, <<https://doi.org/10.1257/aer.100.3.641>>. Recent scholarship has applied this framework to blockchain governance: Sangita Gazi and others, 'Blockchain as Commons: Applying Ostrom's Polycentric Approach to Blockchain Governance' (2022) ahead of print, *SSRN Electronic Journal*, <<https://doi.org/10.2139/ssrn.4250547>>; European University Institute, *Blockchain Technology and Polycentric Governance* (Publications Office 2024), <<https://data.europa.eu/doi/10.2870/049527>>. However, as Keith Carlisle and Rebecca L Gruby explain, polycentric systems require not merely multiple centres but also 'competitive and cooperative relationships' capable of 'resolving conflicts' – elements often absent in blockchain governance, Keith Carlisle and Rebecca L Gruby, 'Polycentric Systems of Governance: A Theoretical Model for the Commons' (2019) 47(2) *Policy Studies Journal* 927, <<https://doi.org/10.1111/psj.12212>>. Importantly, polycentricity differs from simple decentralization: while the latter concerns structural distribution of power, the former requires functional coordination among multiple decision-making centres operating within shared rules. See Paul D Aligica and Vlad Tarko, 'Polycentricity: From Polanyi to Ostrom, and Beyond' (2012) 25, 2 *Governance* 237, <<https://doi.org/10.1111/j.1468-0491.2011.01550.x>>.

⁴⁴ While Achebe and others make valuable contributions regarding blockchain's technical capabilities in compliance monitoring, their theoretical framework remains only partially persuasive. Their analysis tends toward technological determinism in suggesting that blockchain can 'reinvent' corporate governance without sufficiently interrogating whether such 'reinvention' operates within or against the existing legal order. Victor Chinedu Achebe and others, 'Blockchain as a Legal Compliance Infrastructure: Reinventing Corporate Governance and Internal Control Systems' (2024) 11(4) *Int'l J. Sci. Res.* 467, <<https://doi.org/10.32628/IJSRST24115121>>.

5. *Beyond Functional Equivalence: The Imperative of Institutional Innovation*

The nature of decentralized systems, transcending territorial boundaries and relying on code for execution, would demand flexibility in legal classification and execution.

For tokenization, legal fitness requires moving beyond rigid conceptual definitions towards a functional analysis. Tokens are often polyhedral, potentially fulfilling multiple legal roles depending on their characteristics and the context.⁴⁵ While technological neutrality and functional equivalence provide the indispensable lens for jurists to analyse and classify new digital phenomena, they function best when the latest technology aligns with existing institutional logic (e.g., highly centralized, entity-based DLTs). When encountering truly disruptive elements – such as the inherent probabilistic finality of PoW consensus,⁴⁶ the anonymity of users, or the anti-institutional ethos of DAOs – these principles reveal their inadequacy. They provide a descriptive analysis (what the technology *does* economically) but falter in prescribing solutions for the new normative concerns (how to assign accountability and ensure justice when political and territorial constraints are deliberately circumvented).

The theoretical and practical implications suggest that regulatory frameworks need to adopt a nuanced approach. First and foremost, it is essential to embrace functional regulatory standards. However, it is not a convincing argument that regulations should focus on the economic activities being performed rather than the technological specifics, such as defining a token as a security irrespective of its underlying code. Additionally, there is a need to mandate legal bridges that address the challenges posed to core legal principles like property rights, liability, and finality.

⁴⁵ On the polyhedral nature of tokens requiring functional analysis, see ESMA, ‘Advice on Initial Coin Offerings and Crypto-Assets’, 9 January 2019, <<https://www.esma.europa.eu/document/advice-initial-coin-offerings-and-crypto-assets>> accessed 8 February 2026, emphasising that crypto-assets may simultaneously exhibit characteristics of multiple legal categories. However, as discussed above, functional analysis alone proves insufficient when tokens deliberately circumvent traditional institutional frameworks. For the broader challenge of classifying tokens, see one of the first legal studies on this matter: Filippo Zatti, *Entangled in Cryptoassets’ Legal Nature and Governance: Searching for Clear Boundaries or Working for Their Removal?*, SSRN Scholarly Paper ID 3335793 (Social Science Research Network 2019), <<https://doi.org/10.2139/ssrn.3335793>>.

⁴⁶ Probabilistic finality in Proof-of-Work blockchains creates fundamental tension with legal requirements for absolute transaction finality. Unlike traditional payment systems where transactions achieve legal finality at specified moments (see Directive 98/26/EC on Settlement Finality), PoW blockchains offer only probabilistic certainty that increases asymptotically with block confirmations but never reaches 100%. On the technical aspects, see Satoshi Nakamoto, ‘Bitcoin: A Peer-to-Peer Electronic Cash System’ (2008) <<https://bitcoin.org/bitcoin.pdf>> accessed 5 February 2026 section 11. The legal implications are explored by Barresi (see above), demonstrating that law must impose ‘legal finality’ through institutional mechanisms where technology cannot provide deterministic outcomes. This exemplifies the concept introduced in Section 3: law operates as ‘supplier of fictional certainty’ where reality proves irreducibly uncertain. The gap between probabilistic and legal finality illustrates why pure technological solutions cannot replace legal institutional frameworks – mathematics cannot provide the absolute certainty that commercial transactions require.

The law should actively work to create these ‘legal links,’ which may involve establishing new legal categories for decentralized entities and categories or explicitly connecting on-chain technical realities to off-chain legal frameworks through complete tokenization.

Moreover, legal intervention must acknowledge the inherent trade-offs involved in these scenarios. Efforts to impose conventional accountability mechanisms, such as requiring a liable operator, could unintentionally undermine decentralization that these technologies aim to achieve, leading to increased centralization.⁴⁷ Therefore, the objective is not to achieve total technological integration but rather to foster a constructive dialogue in which legal safeguards are introduced to uphold fundamental values, such as human dignity and fairness, within these emerging transnational regimes.

In conclusion, technological norms and functional equivalence are far from obsolete; instead, they need to be thoughtfully balanced with the introduction of tailored legal rules and institutional requirements, particularly in areas where technological design choices pose unique and unacceptable societal risks.

⁴⁷ The trade-off between imposing conventional accountability mechanisms and maintaining genuine decentralization represents a fundamental regulatory dilemma. As discussed above, attempts to identify responsible parties may create hybrid structures satisfying neither decentralization’s efficiency promises nor traditional law’s accountability requirements. This tension is evident in the EU DLT Pilot Regime (see above): while accommodating blockchain innovation, it mandates operator identification and liability chains, thereby imposing centralization as the price of legal integration. For theoretical analysis of this unavoidable trade-off, see Werbach (n 15) 95ff arguing that governance mechanisms requiring human intervention ultimately re-centralize ostensibly decentralized systems.