

Blockchain and Smart Contracts: Legal Issues and Regulatory Responses Between Public and Private Economic Law

Riccardo de Caria*

Abstract

The article investigates some of the most relevant legal issues that emerge in connection with blockchain technology and smart contracts by addressing them from a public policy perspective. In particular, it focuses on some under-investigated problems connected to some possible legal hurdles to their widespread adoption in the legal practice of business at the national and international levels.

The legal analysis of blockchain and smart contracts is then employed to explore the more general question of how much the law needs to change in order to accommodate new technologies, or how much it is instead preferable to believe that the existing law is already capable of accommodating innovation, however radical it may be.

I. General Framework and Premise of Legal Policy

This work aims to take stock of the main legal issues that have emerged and are emerging in connection with blockchain technology and smart contracts. While giving account, at a *descriptive* level, of the laws that have already been approved, the focus will be mostly on the *prescriptive* level, ie, on how the legislature should arguably best tackle this novelty. I will thus question the appropriateness of the choices made so far by the Italian legislature, in the wake of a series of other legal systems which have introduced new specific rules in this field. On this basis, I will reflect on the direction that would be more appropriate for legislators to follow in the future.

I will, therefore, give an account of the recent legislation introduced by the Italian legislature. I shall not, however, dwell particularly on these aspects, nor on the data that emerge from a comparative analysis. This is partly because other works already exist which are dedicated to them,¹ and in general because

* Assistant Professor of Comparative Public Law, University of Turin. I would like to express my debt to the participants at the conference on *Blockchain e diritto (Blockchain and Law)*, held in Turin on 30 May 2019, for their precious reflections, which have been of great help in drafting these pages. The following references to the Turin conference are to be understood as referring to this initiative. I also wish to thank Angelo Rainone for his bibliographical help.

¹ Cf in particular within R. Battaglini and M.T. Giordano eds, *Blockchain e smart contract* (Milano: Giuffrè, 2019).

on the subject, however new it may be, there already exists a relatively large amount of literature.² Above all, I would instead devote myself to some considerations of legislative policy, in order to frame the subject within the more general framework of Italian private and public law, with particular reference to the private and public law of the economy.

As I will say more extensively in the final paragraph, these considerations have to do with the more general question of how much the law needs to change in order to accommodate new technologies. The underlying hypothesis is that it is preferable to consider that the existing law is perfectly capable of accepting innovation, however radical that may be, without having to frantically try to catch-up with the novelty, an effort that even appears to be poised to fail.³

The theoretical questions appear fundamental, especially in a new context such as the one under examination, and need to be properly addressed to endow also practicing lawyers with a sufficiently clear legal framework in their daily application of the existing rules to the matter under consideration. In other words, it does not seem possible to deal profitably with the issue of the law applicable to blockchain and smart contracts, for example,⁴ without posing the question: what is the legal context in which these innovations take place?

In other words, despite certain positions to the contrary,⁵ it seems that this technological innovation is no exception, and just as any other innovation it does not actually take place in a vacuum.⁶ To speak of a 'regulatory vacuum', as sometimes is done regarding these areas,⁷ therefore seems improper.⁸ The idea

² Cf, for instance, A. Alù, 'Blockchain, le principali normative nazionali al mondo' *Agenda Digitale* (19 February 2019), available at tinyurl.com/yae4cell (last visited 7 July 2020); within the legal scholarship, cf, for instance, S. Blemus, 'Law and Blockchain: A Legal Perspective on Current Regulatory Trends Worldwide' *Revue Trimestrielle de Droit Financier* N°4-2017 (December 2017).

³ I will also not deal, if not accidentally, with cryptocurrencies and ICOs, a subject difficult to separate, for which many of the considerations that I will make here are, however, equally valid, *mutatis mutandis*.

⁴ On which cf, for instance, C. Poncibò, 'Smart Contract: profili di legge applicabile e scelta del foro', in R. Battaglini and M.T. Giordano eds, n 1 above, 347; the Authors rightly speaks of a 'false problem' in this regard.

⁵ Cf, for instance, D. Mimran, 'Spanning the Chasm: The Missing Link in Tech Regulation Part 1' OECD *Forum Network series on Digitalisation* (26 April 2019), available at tinyurl.com/ya5ybf6 (last visited 7 July 2020): 'For three decades governments across the globe have created an enormous regulatory vacuum due to a profound misunderstanding of the magnitude of technology on society. As a result, they neglected their duty to protect society in the mixed reality of technology and humanity'.

⁶ Cf S. Deakin and C. Markou, 'The Law-Technology Cycle and the Future of Work' *Centre for Business Research, University of Cambridge Working Paper*, 504 (2018): 'technology never operates in a legal vacuum'.

⁷ Cf eg D. Heller, 'Initial Coin Offerings: Crowdfunding in a regulatory vacuum' *Peterson Institute for International Economics, Realtime Economic Issues Watch* (25 August 2017), available at tinyurl.com/y8exjxov (last visited 7 July 2020).

⁸ This seems to have been the conclusion shared by the participants at the EU Blockchain Observatory and Forum workshop, held in Paris on 12 December 2018 on *Legal Recognition*

of a 'lacuna' in the law, criticized here, inevitably implies that innovation can develop adequately only in the presence of *ad hoc* regulation: until this comes around, the law is unequipped. Indeed, from this perspective, existing law, which was thought of and written long before the emergence of the so-called new technologies, and especially blockchain technology, cannot be deemed capable of making room for innovations like these.

In the following pages, I will first deal briefly with the question of the legal nature of the blockchain and smart contract, logically a priority to all the other ones that emerge when one reflects on the innovation in question and considers its main practical applications (§ II). Then, I will deal in-depth with those issues that, at least at the present time, appear to be the most current and most relevant on a systematic level concerning blockchain and smart contracts.⁹ Both of them, in fact, pose many problems of a theoretical and practical nature. Some of them have already found fairly precise and consolidated answers, such as those on applicable law and the competent court;¹⁰ others are the subject of extensive reflections in the world literature, such as those relating to intellectual property law,¹¹ and the protection of the confidentiality of personal data.¹²

In my opinion, however, there are still several aspects, to a certain extent lying in between blockchain and smart contracts, on which it does not appear that the scholarship has yet reached sufficiently consolidated conclusions, such as effectiveness and remedies (§ III). In some other cases, the legal scholarship has formulated considerations of *law and public policy* that lend themselves, in my opinion, to wide margins of criticism (§ IV). I will then deal with a series of still largely under-investigated problems arising in the interaction between blockchain and smart contracts, on the one hand, and existing law, on the other (§ V). Finally, I will focus on an aspect that seems to have been the subject of insufficient reflection so far, and therefore deserving of further investigation, namely the question of the practical usability of smart contracts in the legal practice of business at national and international levels (§ VI). Then, I will make some concluding remarks in the field of *policy* (§ VII).

of Blockchains and Smart Contracts: cf its report, in particular 7, available at tinyurl.com/yc8kbt4 (last visited 7 July 2020).

⁹ On the subject, among others, cf L. Parola et al, 'Blockchain and smart contract: open legal questions' *I contratti*, 681 (2018).

¹⁰ On which cf C. Poncibò, n 4 above.

¹¹ Cf, for instance, G. Noto La Diega and J. Stacey, 'Can Permissionless Blockchains be Regulated and Resolve Some of the Problems of Copyright Law?', in M. Ragnedda and G. Destefanis eds, *Blockchain and Web 3.0: Social, Economic, and Technological Challenges* (Abingdon: Routledge, 2019), forthcoming; G. Gurkaynak et al, 'Intellectual Property Law and Practice in the Blockchain Realm' 34(4) *Computer Law & Security Review*, 847 (2018).

¹² Cf for instance, among many, T. Buocz et al, 'Bitcoin and the GDPR: Allocating Responsibility in Distributed Networks' 35(2) *Computer Law & Security Review*, 182 (2019); L. Mörel, 'Blockchain & Data Protection ... and Why They Are Note on a Collision Course' 26(6) *European Review of Private Law*, 825 (2018).

II. Brief Notes on the Legal and Economic Framework of Blockchains and Smart Contracts

The response to all the theoretical and practical questions that arise concerning blockchain technologies and smart contracts depends on how the law qualifies these innovations and on the resulting general framework under which they are construed.

As a first approximation, the blockchains are registers, which contain data, and therefore immediately raise the issue of their possible qualification or not as a database. Depending on whether the blockchains are public or private, the legal relations that one can establish with them will also change. Public blockchains, starting with the one par excellence, or the Bitcoin blockchain, are not owned by anyone. They result from the joint but uncoordinated work, on the one hand, of all those who use them and, on the other hand, of the nodes that validate the transactions, and in doing so, keep the infrastructure operating. The code of public blockchains is by definition open source, and the chain of blocks is continuously changing automatically. A forced change can only occur with an agreement of fifty percent plus one of the nodes, which could give rise to a new blockchain, but it would not change in itself the nature of a good over which no one can individually claim ownership titles or other rights in the broad sense.

From this point of view, the public blockchain appears classifiable, according to the categories of economic theory and economic analysis of law, as a public good,¹³ being endowed with the two characters of non-rivalry and non-excludability. Respectively, in fact, the use of a public blockchain by one subject does not affect the use by others, and no one can prevent others from using it, so much so that they are usually *permissionless*.

The issue is different concerning the so-called private blockchains (typically *permissioned*). In this case, the source code and the resulting database are indeed objects of intellectual property by those who are the authors and hold the keys, and therefore they appear subjectable to intellectual property rules regarding databases.¹⁴

As far as smart contracts are concerned, without dwelling here on the definition issues,¹⁵ I will only highlight what is most relevant from a private law perspective, namely that, according to the approach that seems preferable, the

¹³ Cf T. Cowen, 'Public Goods (entry)' *The Library of Economics and Liberty*, available at tinyurl.com/yb5z683d (last visited 15 October 2019).

¹⁴ On which cf eg M.J. Davison, *The Legal Protection of Databases* (Cambridge: Cambridge University Press, 2009).

¹⁵ On which I have had the opportunity to dwell extensively in other works: cf in particular R. de Caria, 'Definitions of Smart Contracts. Between Law and Code', in M. Cannarsa et al eds, *The Cambridge Handbook of Smart Contracts, Blockchain Technology and Digital Platforms* (Cambridge: Cambridge University Press, 2019). Here, in line with the definition given by the Italian legislator, on which cf in a moment in the text, I will refer to smart contracts only in the narrow sense, or referring to the so-called decentralized ones, based on distributed registers.

agreement that actually qualifies as a contract in legal terms is typically one that is perfected upstream of the smart contract. From this perspective, the smart contract is only an instrument of (self-)execution of the contract, not a contract *per se*: the actual contract is something different, that was concluded before, even though maybe only a fraction of a second earlier.¹⁶

This distinction is perhaps more difficult in the case of smart contracts concluded by adhesion, or even automatically by machines, but it is still conceptually valid even in these cases where a minimal amount of time passes between the formation of the will and the conclusion of the smart contract.¹⁷

The smart contract consists in fact of software, object in turn of intellectual property,¹⁸ and a source of potential liability for the authors in case of malfunctioning. The software is intended to perform certain operations without the possibility of altering or stopping its operation if the conditions on which it depends have occurred.¹⁹

Therefore, it seems right to argue that a smart contract is a source of contractual obligations, as legally valid agreements.²⁰ However, I believe this is true as long as we qualify the ‘smart contract’ as a ‘synecdoche’:²¹ conceptually speaking, the smart contract does not correspond to the agreement, but presupposes it and constitutes a written translation of it (in computer code language).²² Smart contracts will be referred to as the source of the obligations between the parties, but these obligations arise from a will previously formed, which is received and formalized with the smart contract.

Both the blockchain and the smart contracts have today received a sort of normative definition in the Italian legal system by Art 8-ter of the *decreto*

¹⁶ Cf R. de Caria, ‘The Legal Meaning of Smart Contracts’ 26(6) *European Review of Private Law*, 731, 745-750 (2018).

¹⁷ *ibid*; the inventor of the expression himself has publicly voiced his regret on the use of this expression: cf ‘Vitalin Buterik: I quite regret adopting the term ‘smart contracts’ for Ethereum’ *Bitcoinist* (14 October 2018), available at tinyurl.com/ybwtrguf (last visited 7 July 2020).

¹⁸ Cf, for instance, the well-known provision in the UK Copyright, Designs and Patents Act related to computer-generated works, whose author ‘shall be taken to be the person by whom the arrangements necessary for the creation of the work are undertaken’ (s. 9(3)).

¹⁹ Cf A.J. Kolber, ‘Not-So-Smart Blockchain Contracts and Artificial Responsibility’ 21 *Stanford Technology Law Review*, 198 (2018), for some reflections on the issue of artificial responsibility. Similar considerations can also be found in P. Cuccuru, ‘Blockchain ed automazione contrattuale. Riflessioni sugli smart contract’ *La Nuova Giurisprudenza Civile Commentata*, 107-119 (2017).

²⁰ R. de Caria, ‘The Legal Meaning’ n 16 above, 746.

²¹ Cf P.G. Monateri, *La sinecdoche. Formule e regole nel diritto delle obbligazioni e dei contratti* (Milano: Giuffrè, 1984).

²² Cf, well before the rise of blockchain, T. Allen and R. Widdison, ‘Can Computers Make Contracts?’ 9(1) *Harvard Journal of Law and Technology*, 25 (1996), that dealt with the issue from a distance, attempting to articulate the requisites that a digital contract needs to meet in order to be deemed an actual agreement, in the sense of ‘meeting of the minds’. Much more recently, specifically on smart contracts, see, for instance, M.L. Perugini and P. Dal Checco, ‘Introduzione agli Smart Contract’, available at tinyurl.com/yxd2ybto (last visited 7 July 2020).

semplificazioni.²³ However, without prejudice to the general criticism of this regulatory choice, both in general and in its particular modalities of implementation, on which I will return in the concluding paragraph, such definitions do not appear able to give new answers to the issues of systematic framing that have confronted the interpreters. In fact, the Italian legislature, in its haste to regulate the new cases in an operation that has been appropriately defined as ‘regulatory marketing’²⁴ seems to have intended to create new, standalone categories. In my opinion, this does not make at all irrelevant the linking of these innovations to existing legal categories, and therefore the considerations made above remain applicable.

III. Effectiveness and Remedies with Regard to Smart Contracts

A first aspect to consider concerns the technical quasi-impossibility of stopping the self-execution of a smart contract, or in any case transferring data or wealth on a blockchain. In fact, even where the law prescribes them, and even where there is a judge who orders them, these actions require the spontaneous collaboration of those who hold the private keys of the wallet that contains the relevant data or digital wealth. The command of the judge, it is said, risks being blunt and ineffective.²⁵ From a technical point of view, unless one puts in place a *hard fork*, which would compromise the underlying assumption of immutability of the blockchain, it is not possible to transfer Bitcoins to someone without the collaboration of the current owner (to be sure, of the person who currently holds the keys of the wallet that ‘contains’ them).²⁶ From this perspective, if the keys are only available in the mind of their holder, and the holder does not cooperate, no seizure or bailiff will ever be possible.²⁷

²³ Decreto legge 14 December 2018 no 135, converted into legge 11 February 2019 no 12.

²⁴ For instance, by G. Finocchiaro at the conference mentioned above in Turin.

²⁵ See, for example, the decree by the Tribunale di Brescia, sezione specializzata imprese 18 July 2018 no 7556, available at www.dejure.it, rejecting a company’s appeal against a notary’s refusal to record in the commercial register a resolution to increase capital employing the contribution in kind of a crypto-currency unit (in this case, of one being ‘still at an embryonic stage’). Making a consideration which appears extendable to any crypto-currency unit, the decree finds that, in this case, there is a lack of ‘suitability of the asset to be the object of aggression by creditors’: in fact, it is necessary to ask oneself the question of the ‘modalities of execution of a hypothetical attachment of the crypto-currency object of assignment, (...) in the light of the well-known existence of security devices with a high technological content which could make it impossible to expropriate them without the consent and spontaneous collaboration of the debtor’; for a comment in a critical sense, see. M. Bellino, ‘Società - Conferimenti in criptovalute: condizioni e limiti’ *La Nuova Giurisprudenza Civile Commentata*, 54 (2019).

²⁶ The issue of immutability has some apparent repercussions in the field of personal data protection, a widely-debated topic on which see, among many, A. Giannopoulou and V. Ferrari, ‘Distributed Data Protection and Liability on Blockchains’ *Amsterdam Law School Research Paper*, 6 (2019), available at tinyurl.com/y6qnkpdv (last visited 7 July 2020).

²⁷ To be sure, cases of seizure have taken place, even if they were brought against intermediaries or exchanges: some instances date back already to 2015 (cf ‘Pedopornografia, indagine sul Deep Web: sequestrata criptomoneta’ *Il Corriere della Sera*, available at

Similarly, if it is established, possibly even by a judge, that a smart contract contains a programming error that produces results contrary to justice, or that the contractual agreement on the basis of which it was written was based on an error or anyway on a faulty assumption,²⁸ there is no way to stop the self-execution of the smart contract. For the reasons set out above, it may then be technically impossible to remedy, with the consequence that the remedies offered abstractly by the law are, in fact, ineffective. If we imagine a debtor who has tokenized all his wealth, there are no assets on which the creditor can satisfy himself with the ordinary enforcement procedures, and therefore his rights end up being frustrated.

This situation would be one of the many examples in which computer code is about to replace the law, with a whole series of relevant implications. In this case, computer code would even neutralize the practical effects of the Weberian monopoly on the legitimate use of force. At least today, the force of cryptography would be more potent than what, for some centuries, has been one of the cornerstones of sovereignty. This would open a possible attack on sovereignty of a scope unknown until now.²⁹

To be sure, it must be recognized that the practical ineffectiveness of the remedies is a fact already quite common today, which in itself does not undermine the theoretical structure of the system.³⁰ Already today it is possible that the debtors are destitute, either because they have squandered the assets constituting their guarantee, or because they have transferred them to third parties which are not possible to track or through operations that are not possible to trace, or for other reasons still. However, this is a matter of fact and does not in itself call into question the theoretical construction of law as we know it.

Unquestionably, even the fact acquires its capacity to undermine the theoretical foundations where the exception is more frequent than the rule.³¹ In this case, if the problem of scalability finds a full solution and these practices reach massive adoption, then a theoretical rethinking could be necessary, but until then, the construction can withstand.

This consideration also makes it possible to respond to the issue raised by some authors concerning particularly damaging provisions for one of the parties, contained in a smart contract. In itself, the law does not give up on the protection of the consumers, for example, through the recognition of the unfairness of specific

tinyurl.com/ya2j4lx8 (last visited 7 July 2020); more recently, cf. an order of seizure by the Tribunale di Firenze in June 2018.

²⁸ This generally refers to the theme of interpretation, on which cf. M. Cannarsa, 'Interpretation of Contracts and Smart Contracts: Smart Interpretation or Interpretation of Smart Contracts?' 26(6) *European Review of Private Law*, 773 (2018).

²⁹ On this subject, cf. R. de Caria, 'Blockchain-Based Money as the Ultimate Challenge to Sovereignty. Reflections from a Public Economic Law Perspective' 6(2) *European Journal of Comparative Law and Governance*, 131 (2019).

³⁰ On the remedial use of coding, see L. Lessig, *The Future of Ideas: the Fate of the Commons in a Connected World* (New York: Random House, 2002).

³¹ Cf. Caterina's speech at the conference in Turin.

clauses that may feature in (the contractual agreement upstream of) the smart contract. Of course, there may be a problem of effectiveness here too, due to particular practical difficulty in benefiting from a court ruling establishing such unfairness. However, the reasoning just expressed remains firm.³²

IV. Economic and Social Considerations

In this paragraph, I would like to make some reflections on a public policy level, because some regulatory choices may depend on this. Firstly, a common criticism of these technologies is that of their energy-environmental impact.³³ The interesting fact is that it does not appear to be an incidental feature of theirs, but rather, in some way, it was programmatically inscribed in their original design. In fact, the incentive mechanism created, in line with game theory, through the *proof of work*, is built specifically on extremely complex mathematical problems, which require significant computing power to be solved and, therefore, inevitably involve a high expenditure of energy resources. To be sure, the high cost serves precisely to discourage the so-called fifty one percent attacks (ie attempts to gain control of more than half of a network's hash rate), making them more expensive than the gain that can be made.³⁴

I believe, however, that we can and must overcome this objection if we consider the issue from a market perspective, which would provide for a reallocation of the negative externalities. The market will be very effective in finding a balance between the value of Bitcoin and energy costs, or better in factoring the latter into the former. When the fundamental activity of providing computational power to validate blocks of transactions (ie mining) should become economically inconvenient, this will create the incentive to find new technological solutions. Therefore, it appears to be a hardly unresolvable problem.

Similar considerations apply concerning the question of the computing power used precisely for mining. In essence, it has been observed that, regardless of energy costs, this computing power could be used in a much more socially sustainable way, for example, in the service of research in the medical-scientific field.³⁵ Also in this case, however, it does not seem that the legislature or the

³² P. De Filippi and A. Wright express a different position in 'Decentralized Blockchain Technology and the Rise of Lex Cryptographia', 26 (2015), available at tinyurl.com/yyom5eth (last visited 7 July 2020).

³³ Cf, among many, J. Truby, 'Decarbonizing Bitcoin: Law and policy choices for reducing the energy consumption of Blockchain technologies and digital currencies' 44 *Energy Research and Social Science*, 399 (2018).

³⁴ Cf S. Nakamoto, 'Bitcoin: A Peer-to-Peer Electronic Cash System', 3 (2008), available at tinyurl.com/kkxbyss (last visited 7 July 2020): 'To compensate for increasing hardware speed and varying interest in running nodes over time, the proof-of-work difficulty is determined by a moving average targeting an average number of blocks per hour. If they're generated too fast, the difficulty increases'.

³⁵ Cf G. Boella at the Turin conference.

regulator can have the ‘fatal conceit’³⁶ of knowing what is the preferable use of an economic resource. The Coase theorem³⁷ remains a useful policy caveat against coercive reallocation of property titles or wealth, being it preferable to rely, for socially desirable outcomes, on the free negotiation of operators.

The discussion is different (although the conclusion is similar) with regard to the problems posed by the self-executing nature of smart contracts in relation to the protection of the weaker party.³⁸ Indeed smart contracts allow the stronger party to exercise extensive self-protection in the face of counterparty default, something that the law tends to look at with suspicion.³⁹ Let us think of the fact, criticized by many,⁴⁰ whereby car companies can automatically suspend the operation of a vehicle remotely if the person who bought it in installments is late for even a single day in settling even one installment.

This action has been technically possible for several years now,⁴¹ and could be achieved even more efficiently by resorting to smart contracts. The danger feared is that this will end up giving the stronger parties even more effective weapons for the protection of their contractual interests. In essence, this perspective feeds the paradigm of Marxist reminiscence of the law of the strongest, or rather of the law as an instrument of the economically stronger classes.⁴²

However, I repeat here the considerations made in the previous paragraph concerning effectiveness. In essence, the law today in many jurisdictions provides for particular sets of rules to protect subjects or groups of subjects placed in a disadvantaged position, as is typically the case for laws to protect consumers. These new instruments could indeed lead to an increase in the number of breaches of such laws, and in many cases, it might be challenging to obtain adequate remedies in practice. However, in theory, consumer law, as well as other laws protecting the weak parties, would remain in place, so even this criticism does not seem to be acceptable. This seems to be true in general for all areas in which the law does not allow something that new technologies make it

³⁶ F. von Hayek, *The Fatal Conceit: The Errors of Socialism* (Chicago: Chicago University Press, 1988).

³⁷ According to which, as is well known, in the absence of transaction costs, in order to reach an economically efficient solution, the original allocation of property titles is indifferent.

³⁸ In this regard, it is worth mentioning J. Fairfield, ‘Smart Contracts, Bitcoin Bots, and Consumer Protection’ 71(2) *Washington and Lee Law Review*, 35 (2014), who expresses his favour for the use of smart contracts for consumer protection (in his view, the greatest obstacle to consumer protection is the need to go to court).

³⁹ On the subject, see, among many: A. Rappazzo, *L'autotutela della parte nel contratto* (Padova: CEDAM, 1999); A. Dagnino, *Contributo allo studio dell'autotutela privata* (Milano: Giuffrè, 1983).

⁴⁰ Cf E. Stucchi at the conference in Turin. Cf also P. de Filippi and A. Wright, n 32 above, whereby the authors express skepticism about this possibility.

⁴¹ Cf M. Corkery and J. Silver-Greenberg, ‘Miss a Payment? Good Luck Moving That Car’ *The New York Times*, available at tinyurl.com/y3r6yyax (last visited 7 July 2020).

⁴² Cf, among many others, E. Ripepe, *Alla ricerca della concezione marxista del diritto: con un'appendice in tema di crisi nel e del marxismo* (Torino: Giappichelli, 1987).

particularly easy to implement, such as in the case of so-called *smart wills*. At least in the Italian legal system, such forms of wills clash with the apparently insurmountable prohibition of agreements as to future successions.⁴³

Finally, a remark that some authors make relates to the possible weakening of the solidarity obligation that would characterize the insurance contract in particular. This evolution would be an expression of a general tendency of the *insurtech* business to individualize risk assessment and consequently policies,⁴⁴ a trend that would be further increased by distributed ledger technologies. The result would amount to a sort of demutualization of insurance,⁴⁵ to the detriment of policyholders who are less attractive to companies, and whose insurance costs are currently split, through a statistical-actuarial procedure, among the community of policyholders at lower risk, but who may be denied coverage in the future.⁴⁶

However, it is questionable that the insurance contract must necessarily be vested with this redistributive socio-economic function.⁴⁷ As the best literature on health reform in the United States has shown,⁴⁸ the most efficient solution from a *policy* perspective is not to force companies to insure non-insurable subjects. Therefore, the concern about the increased level of individualization of policies does not seem to be justified. If anything, the legislature will always be in a position to decide to take charge, not of the cost of the policy (through the general taxation, or with indirect taxation on the companies), but of the service (in this case, of health care) requested explicitly by its citizens, in one of the various forms in which this social right can be provided.⁴⁹

⁴³ Cf M. Minelli, 'Blockchain, smart contract e successioni (testamentarie): profili problematici e possibili soluzioni', in R. Battaglini and M.T. Giordano eds, n 1 above.

⁴⁴ Cf D. Poletti at the Turin conference. Cf also the EIOPA study *EIOPA InsurTech Roundtable – How technology and data are reshaping the insurance landscape*, 2017, available at tinyurl.com/yxlsx7ox (last visited 7 July 2020).

⁴⁵ Cf, for instance, G. Boella at the conference in Turin.

⁴⁶ On the role of big data in the insurance sector, with regard to the blockchain technology, cf M. Mainelli and C. von Gunten, *Chain Of A Lifetime: How Blockchain Technology Might Transform Personal Insurance* (London: Z/Yen Group, 2014).

⁴⁷ For a reflection on this point, T. Baker and K.D. Logue, *Insurance Law and Policy: Cases and Materials* (Alphen aan den Rijn: Wolters Kluwer, 2017), 14-15.

⁴⁸ Cf, among many, The Council of Economic Advisers, 'Deregulating Health Insurance Markets: Value to Market Participants', available at tinyurl.com/y7vzbzorb (last visited 7 July 2020); A. Monahan, 'On Subsidies and Mandates: A Regulatory Critique of ACA' 36 *Journal of Corporation Law*, 781 (2011).

⁴⁹ Cf R. Caterina at the Turin seminar. Other considerations that scholars brought forward (eg, Paolo Gallo at the same conference) about the links between blockchain and insurance law, concern the possible moral hazard that would result from the fact that the insured party is sure to obtain satisfaction when certain conditions occur. However, even in this case, it seems instead that the reduction of transaction costs that these technologies involve deserves a positive assessment, and that this risk is not so serious, given that in general the events from which the payment of a sum in favor of the insured derives are negative for them.

On the other hand, the application of the blockchain technologies to insurance brings to our attention the complex issue of the lawfulness of insurance contracts on events involving third parties that do not have and impact on the life or property of the policyholder. Also this

Therefore, in conclusion, there do not appear to be well-founded arguments of public policy to limit, let alone prohibit the use of promising technologies such as those at the base of the blockchain and smart contracts. First, despite the possible practical difficulties that I have mentioned, the legislation already existing allows to satisfy all the public policy needs that the legislator wants to protect. Secondly, the protection of specific categories of subjects can more efficiently take place on the level of public welfare than on that of the ‘conformation’ of contractual relations.⁵⁰

V. Interaction with Existing Public and Private Law of the Economy

In this paragraph, I will briefly consider some issues that are particularly worthy of reflection for lawyers, raised by the innovations under consideration.

A first question concerns the issue of the so called ‘heterointegration’ of the contract.⁵¹ By definition, the smart contract must be or for that matter is presumed to be complete, or at least as complete as possible, and especially on a technical level it does not allow room for external additions. However, the reader should again remember that the contractual agreement upstream of the smart contract will be subject to integration by the judge. The smart contract latter will be executed in any case upon the occurrence of certain conditions, but the judges will always be able – if one generally admits their heterointegrative powers – to review the outcome in terms of justice, and possibly to order a readjustment of the contractual obligations for the sake of equity or fairness.⁵² Once again, there may be a problem in terms of the effectiveness of the remedies, but on a theoretical level, the use of smart contracts does not appear to imply any conceptual revolution. In essence, already today, in the field of contracts, the law regulates much less than what it is recounted on the ground of ‘declamations’.⁵³ The scenario would not change with this new way of executing contracts.

practice is made more accessible by the new technologies in question (and here too, it seems possible to observe that the general principles governing insurance contracts will not cease to apply solely because of the emergence of these disruptive technologies).

⁵⁰ On the subject, cf the recent study by C. Solinas, *Il contratto amministrato: la conformazione dell'operazione economica privata agli interessi generali* (Napoli: Edizioni Scientifiche Italiane, 2018); for considerations similar to those expressed in the text, about a well-known case of abuse of contract law, cf R. de Caria, ‘La nuova fortuna dell’abuso del diritto nella giurisprudenza di legittimità: la Cassazione sta “abusando dell’abuso”? Una riflessione sul piano costituzionale e della politica del diritto’ *Giurisprudenza costituzionale*, 815 (2010).

⁵¹ On the subject, see, among many, the work of C.M. Nanna, *Eterointegrazione del contratto e potere correttivo del giudice* (Padova: CEDAM, 2010).

⁵² For some considerations along these lines, see M. Verstraete, ‘The Stakes of Smart Contracts’ 50 *Loyola University Chicago Law Journal*, 743 (2019).

⁵³ On the subject of the essays by M. Graziadei, ‘La legge, la consuetudine, il diritto tacito, le circostanze’, and D. Francavilla, ‘Diritto e conoscenza non linguistica. Osservazioni su origine, trasmissione e diffusione delle regole’, both in R. Caterina ed, *La dimensione tacita del diritto* (Napoli: Edizioni Scientifiche Italiane, 2009), 49 and 65 respectively.

The question of whether the complexity of the law, with its nuances and general clauses, can be reduced to the binary logic that governs information technology appears to be more insidious. The issue is, as is well known, the subject of very broad reflection,⁵⁴ and there are some interesting attempts to reduce the regulation of financial markets to the blunt yes/no alternative, for example.⁵⁵ For contract law, this seems more difficult. However, it seems that the consideration repeatedly made here is once again valid. In essence, one thing is the method of execution, automated by smart contracts, another one is the contractual agreement itself, where the judge will have the opportunity to highlight all the possible nuances of human action, including through the general clauses.

Once again, considerations in line with what I have already reiterated should arguably be reached by looking at the applicability in these areas of other areas of the law, such as competition law.⁵⁶ What is decisive for *permissionless* public blockchains is that no one controls fifty percent plus one of the nodes. Already today, however, since *mining* has become expensive, there are, as is well known, pools of miners, so there is a well-founded risk that an agreement of very few subjects that control the handful of dominant pools could compromise the system.⁵⁷ Undoubtedly, in this scenario, competition law regulates the behavior of such subjects in a particularly cogent way.⁵⁸

A related issue, more fascinating but also more difficult, which can only be mentioned here, is what legal treatment should a so-called fifty one percent attack receive: is it an unlawful act, as such subject to sanctions, or not? In other words, is this type of attack, which is lethal to the credibility of the system, prevented only by technical protections geared on incentives for the participants (*proof of work*, *proof of stake*) which as such can change or even be violated in the case of 'players' who do not behave like a rational agent (think of the hypothetical work of a government that decides to do 'whatever it takes' to knock down the Bitcoin blockchain, at any cost, for political reasons). Or does a fifty-one percent attack also violate rules of a legal nature, and if so, which ones?

This question seems, as I said, to be more challenging to answer, which brings me to the last question.

⁵⁴ Among many, cf C. Markou, *Lex Ex Machina: The Rule of Technology in the Post-Human Future*, forthcoming 2020; with specific reference to the contractual scope, cf H. Surden, 'Computable Contracts' 46 *UC Davis Law Review*, 629 (2012).

⁵⁵ This is what the Swiss startup Apiax (www.apiax.com) is committed to.

⁵⁶ Cf the writings of T. Schrepel, 'Collusion by Blockchain and Smart Contracts' 33 *Harvard Journal of Law & Technology*, 118-166 (2019); and Id, 'Is Blockchain the Death of Antitrust Law? The Blockchain Antitrust Paradox' 3 *Georgetown Law Technology Review*, 281 (2019).

⁵⁷ Cf G. Boella at the Turin conference.

⁵⁸ More generally, the issue of how decisions are taken within the community also deserves a great deal of attention from scholars, on the one hand, of public decision-making processes and, on the other, again of competition law, since these are clearly concerted decisions by operators at the same level of the market. Therefore, in my view, it is possible to categorize them as horizontal agreements.

VI. Applicability in the Light of the Current Paradigm of Business Law and Practice

The last point I would like to make is one that appears to have emerged to a lesser extent in the technical and legal literature on the subject, but which I believe deserves close attention.

One of the most commonly referenced potential fields of application of smart contracts is international trade.⁵⁹ In fact, Uncitral and Unidroit have so far been quite active in promoting reflections and studies on the subject.⁶⁰

However, the aspect that I believe has received insufficient attention is that smart contracts are effective in removing the risk of non-execution by one party. They make it virtually impossible if the established conditions are met, that they might end up driving the parties to give up on a series of contracts that both parties would have an interest in concluding anyway. I am referring to all those contracts whereby, at the time of stipulation, one of the two parties does not have the money that they will have to pay when the condition upon which their payment is contingent actually occurs. In other words, it is quite common for economic operators, and certainly not in breach of any law, to simultaneously take on monetary obligations the total amount of which goes well beyond their total net worth.

The total assets guaranteeing the debtors, based on the general rule of liability pursuant established by Art 2740 of the Italian civil code, may remain the same and even be limited, but the subject may use them as collateral for a potentially infinite series of different obligations, which together lead to a much higher capital exposure than the assets themselves.

This scenario is perfectly physiological, especially in typical cases where the *maturities* of such obligations are different and distributed over time so that the debtor can count on future revenues to meet them. This mechanism performs a precise economic function, because it allows to multiply in some way the value of one's assets, and so to succeed in assuming an extensive series of obligations, and so to increase the commercial traffic. In the practice of trading, companies every day assume payment obligations of sums that they do not own at the moment but trust that they will, in fact, own on maturity as a result of their *cash flow*.

Parties can always establish that the debtor, when taking up the obligation, must already dispose of the amount that they will have to pay and keep it frozen at the disposal of the creditor, so that the latter can 'automatically' receive their payment upon the occurrence of the relevant conditions. Such an agreement

⁵⁹ Cf R. de Caria, 'A Digital Revolution in International Trade? The International Legal Framework for Blockchain Technologies, Virtual Currencies and Smart Contracts: Challenges and Opportunities', in *Modernizing International Trade Law to Support Innovation and Sustainable Development. Proceedings of the Congress of the United Nations Commission on International Trade Law. Vienna, 4-6 July 2017. Vol 4: Papers presented at the Congress*, 105 (2017).

⁶⁰ Concerning the former, cf, eg, the volume referred to in the previous fn; concerning the latter, cf, eg, the Colloquium on Financial Markets Law held in Beijing on 29-30 March 2017.

can already be achieved by using a third-party trustee to act as an escrow. Smart contracts reproduce this mechanism, achieving the same result in practice, but making the intermediation of the escrow redundant, or at least partially replacing its role with that of the oracles.⁶¹

The problem is that such practice leads to the immobilization of much more wealth and for much longer than is necessary in itself. It will, therefore, be essential to pay close attention, in the drafting of the smart contract, to ensure that a time limit is well defined within which the condition can be said to have been certainly fulfilled or not. Otherwise, there is the risk that the immobilization will last for a potentially indefinite time, ending up generating uncertainty about the actual owners of a significant amount of wealth (here, Ethers or Bitcoin, in the most typical cases), reproducing some unfortunate outcomes of the past that the commercial practice has had to overcome.

Admittedly, smart contracts respond to a precise economic function, in some way attributable to the lack of trust on the one hand in the creditor, on the other hand, in the ability to obtain satisfaction for one's claim through the ordinary remedies offered by the law. In some way, therefore, the smart contracts, realizing that 'trustless trust' mentioned by many⁶² (even if the parties must place considerable trust in the authors of the smart contract and possibly in some auditors), could actually make viable some economic transactions that otherwise would not be concluded, or that would be concluded only at a higher cost, including the cost of intermediation of trusted subjects of both parties. Nevertheless, it seems that there are still many cases in which the parties prefer to do without such guarantees, in order to reduce transaction costs, and where therefore the mechanism of smart contracts does not currently appear the preferable solution, at least in its most commonly described version.

Moreover, similar considerations can arguably be made with reference to an extensive range of other contracts or contractual clauses: how to reconcile the automatic execution and predetermination of a payment obligation with all the cases in which its amount is not known at the outset? Just to give a few examples, let us think of non-life insurance, or of a penalty clause providing an increasing amount over time, or a short sale, all agreements that provide for a payment dependent on a particular result. In all these cases, resorting to a smart contract, in order to be a coherent choice, would require to block extremely

⁶¹ Cf. A. Egberts, 'The Oracle Problem - An Analysis of how Blockchain Oracles Undermine the Advantages of Decentralized Ledger Systems', available at tinyurl.com/y3br5lgt (last visited 7 July 2020). In this respect, the practice of multi-sig contracts also seems to introduce the intervention of a third party, which at least in part mitigates the automatic character of smart contracts.

⁶² Cf. eg. H. Eenmaa-Dimitrieva and M.J. Schmidt-Kessen, 'Creating Markets in No-Trust Environments: The Law and Economics of Smart Contracts' 35(1) *Computer Law & Security Review: The International Journal of Technology Law and Practice*, 69 (2019); M. Zou et al, 'In Code We Trust? Trustlessness and Smart Contracts in Computers and Law' *Society for Computers and Law Journal*, 39-43 (2019).

high sums,⁶³ corresponding to the *worst-case scenario*, but this seems utterly unsustainable economic-wise.

In a hypothetical, futuristic economic scenario where Bitcoins, Ether, and other cryptocurrencies replace *fiat* coins, and where all wealth is somehow tokenized, I think the need would arise, in order for smart contracts to be applied outside a limited range of hypotheses, to find a way of allowing the same cryptocurrency units to be used several times, in a sort of practical alternative to ‘double spending’, which would, however, risk contradicting one of the fundamental principles of the blockchain environment. One way could be the stipulation of contractual agreements linked one to the other, in which the very creation of an obligation is subordinated to the actual arrival of the supply as a result of another contractual agreement, but at least to date, they appear rather complicated and cumbersome. Therefore this appears to be a problem that will require computer scientists and lawyers to think widely, in search of possible solutions.⁶⁴

Indeed, from the point of view taken in this paragraph, smart contracts appear to represent a glaring example of an attempt to ‘escape from the law’,⁶⁵ in the name of its already well-known, and already mentioned above, replacement with computer code.⁶⁶ However, difficulties and challenges as the one now exposed are at the same time proof that the transition is not necessarily so easy or, in any case, of such generalized potential application, as many authoritative scholars foretell.⁶⁷

⁶³ With regard to insurance, this is confirmed by an example made by K. Werbach and N. Cornell, ‘Contracts *Ex Machina*’ 67 *Duke Law Journal*, 101, 119 (2017): ‘Consider a simple insurance contract under which Abby promises farmer Bob, in return for a monthly payment, a lump sum in the event the temperature exceeds 100 degrees for more than five straight days during the term of the agreement. In a traditional contracting arrangement, the parties would likely reduce that agreement to a writing, signed to memorialize mutual intent. If the temperature exceeded the threshold for six straight days and Abby failed to pay, Bob could file suit for breach, and present the contract as evidence. To implement a smart contract with the same terms, Abby and Bob would translate the provisions into software code. *Each would make available sufficient funds to fulfill his or her side of the agreement*’ (emphasis added).

⁶⁴ Technically, a solution already fully feasible today is to admit that the smart contract can be concluded even in the absence of funding in the wallet of the person who assumes the obligation to pay, and that this payment has to occur only when the condition occurs. However, either the main smart contract provides that the main obligation is not executed until the funding is found in the hands of the counterparty (and then you return to the starting point), or the obligation is still executed automatically, and then the smart contract loses one of its primary functions, namely the guarantee of certainty and automaticity of payment and the resulting disintermediation. From the opposite point of view, smart contracts also make the operation of the exception of non-compliance problematic. If automated, the payment will still take place even in the presence of defects in the counter-performance, at least not adequately detected by an oracle. If instead, the payment is subject to prior verification of the absence of defects, in this case, the primary advantage of the mechanism of smart contracts appears again frustrated.

⁶⁵ Cf in this respect the reflections by P. De Filippi and A. Wright, n 32 above, later collected in their book *Blockchain and the Law. The Rule of Code* (Cambridge: Harvard University Press, 2018).

⁶⁶ The classic reference is to L. Lessig, *Code and Other Laws of Cyberspace* (New York: Basic Books, 1999).

⁶⁷ Cf eg H. Eenmaa-Dimitrieva and M.J. Schmidt-Kessen, n 62 above, and already the previous version of their work, ‘Creating Markets in No-Trust Environments Implementing Smart Contracts

VII. Concluding Remarks: A Technological Revolution but not a Legal One

The analysis carried out leads me to some more general considerations, applicable in principle in every area of the law of new technologies, and in my opinion, also to blockchain and smart contracts.

Firstly, when dealing with any innovation, technological or otherwise, the lawyer should arguably always move from a general principle that is too often neglected, namely the principle of freedom or presumption of liberty.⁶⁸ This principle, as is well known codified, with a rather questionable choice, by the Italian legislature in 2011,⁶⁹ should always guide the interpretation of existing law, and should advise against considering that legislative or regulatory intervention is necessary to allow the operation of something that should already be perfectly legal in itself, until any rule to the contrary.

From this point of view, it appears to be entirely open to criticism the choice of by the Italian legislature to rush to legislate in this matter. Furthermore, as has been correctly observed,⁷⁰ in an imprecise manner, and above all by having the opposite effect, of paralyzing, at least temporarily, an innovation which previously could have been freely carried out. Now, it has been made dependent on the adoption of technical standards by the Agency for Digital Italy (AgID) (under para 4 of Art 8-ter of the above-mentioned *decreto semplificazioni*).

In addition, two further severe problems can be identified: on the one hand, there is a significant constitutional law problem, namely that such important rules are entrusted to an entity removed from the circuit of democratic legitimacy, whose acts are difficult to frame in the sources of law system. On the other hand, as has rightly been said,⁷¹ the Italian legislation has violated the principle of technological neutrality,⁷² thus exposing itself to almost inevitable ageing, which can happen even very quickly.

This is arguably all the more reason to rule out the need to call for a regulatory revolution. It has been very opportunely suggested that, at most, we

in No-Trust Environments', published as EUI Department of Law Research Paper No. 2017/13, available at tinyurl.com/yxgxy37l (last visited 7 July 2020). Very interesting considerations more in line with what I have expressed in the text are read in R. Pardolesi and A. Davola, '«Smart contract»: lusinghe ed equivoci dell'innovazione purchessia' *Foro italiano*, V, 195 (2019).

⁶⁸ On the subject, cf Sir J. Laws, 'The Rule of Law: The Presumption of Liberty and Justice' 22(4) *Judicial Review*, 365 (2017); R.E. Barnett, *Restoring the Lost Constitution: The Presumption of Liberty* (Princeton: Princeton University Press, 2003).

⁶⁹ Art 3 of decreto legge 13 August 2011 no 138, converted with amendments into legge 14 September 2011 no 148.

⁷⁰ Eg by G. Finocchiaro at the Turin conference.

⁷¹ Eg by G. Finocchiaro, F. Delfini and E. Stucchi at the Turin conference.

⁷² On the subject, cf for instance W. Maxwell and M. Bourreau, 'Technology Neutrality in Internet, Telecoms and Data Protection Regulation' 21(1) *Computer and Telecommunications Law Review*, 1 (2015); I.M. van der Haar, 'Technological Neutrality; What Does it Entail?' *TILEC Discussion Paper* (2007-2009).

need to reflect on the paradigm of responsibility.⁷³ Our liability law is built around an always possible imputation at least by fault, while in the matter that we deal with, in many cases, it is not necessarily possible to find the author of an error (think of a bug in open source code). In any case, it will not necessarily be a solvent subject, against which it is therefore efficient to go.

In any case, as I believe the analysis carried out in the previous paragraph shows, however revolutionary the technologies under consideration and their practical applications may be, the law must not be revolutionized as well. The more general private law categories are perfectly applicable to blockchain and smart contracts. In fact, they appear much more reliable and durable than the latest legislation because they do not violate the principle of technological neutrality.⁷⁴

As I have had the opportunity to illustrate, some typical operations made technically possible by blockchain and smart contracts, such as smart wills, appear very difficult to reconcile with the existing law, at least in Italy. Similarly, some clauses might be considered unfair, as well as in general, there could be a problem of defective formation of one party's will, to name but a few examples of possible invalidity. As was said, it may be difficult, in practice, to obtain an effective remedy, but this also applies to many cases that have nothing to do with the new technologies. It does not cancel the fact that, in the abstract, the remedy in the legal system exists, which is what ultimately matters the most at a theoretical level.

To conclude, the blockchain and smart contracts certainly seem to represent a promising field of investigation for lawyers. In particular, for those who study the interactions between law and the economic phenomenon, who will have the task of bringing out the various issues that they raise, of which I have tried here briefly to summarize the main ones, at least at present. However, I believe that the technological and economic revolution that they involve does not necessarily go hand in hand with a revolution in or of the law. The escape from the law, and its replacement by computer code, for better or for worse seems to be a long time coming. Or at least it does not seem that distributed ledger technologies and their applications will be the ones to accomplish it, because they can easily develop within the existing legal framework.⁷⁵

⁷³ Eg G. Finocchiaro at the Turin conference.

⁷⁴ F. Delfini at the conference Turin; by this Author, cf also '*Blockchain, Smart Contracts e innovazione tecnologica: l'informatica e il diritto dei contratti*' *Rivista di diritto privato*, 2, 167-178 (2019).

⁷⁵ According to K. Werbach and N. Cornell, n 63 above, 148, new legal answers are warranted, but contract law will not change substantially: 'We believe that smart contracts are not, even theoretically, a substitute for contract law. Consequently, we believe that the above views about contract law's function, which appear to suggest that smart contracts could replace contract law, are unsatisfactory'. Cf also É. Théocharidi, 'La conclusion des smart contracts: révolution ou simple adaptation?' *Revue Lamy droit des affaires*, 138, 28-38 (2018), who expresses a similar view. A different opinion can instead be found in S. Loignon, *Big Bang Blockchain. La seconde révolution d'Internet* (Paris: Tallandier, 2017), 15, or in C. Zolynski, 'Blockchain et smart contracts: premiers regards sur une technologie disruptive' *Revue de Droit Bancaire et Financier*, 4 (2017).